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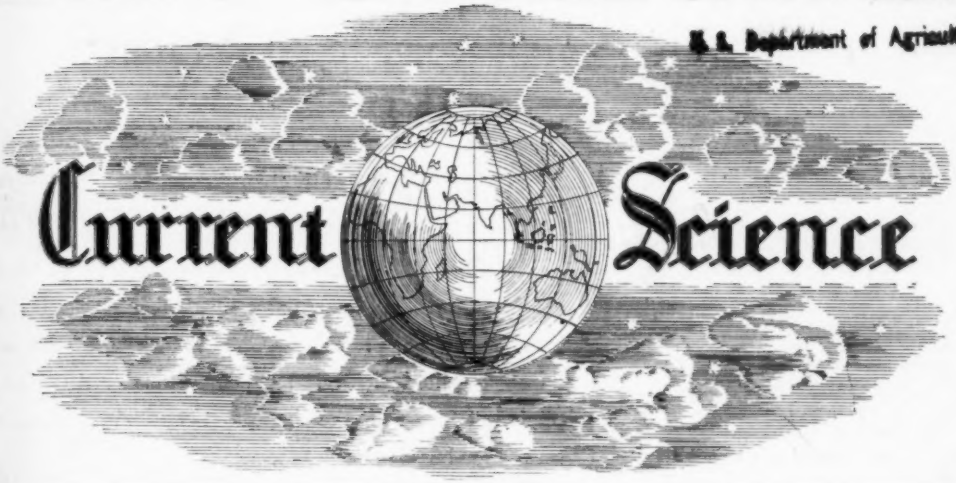

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Problems of Road Research.

AT the second session of the Indian Road Congress held recently in Bangalore, the delegates, mostly Engineers from the different parts of India, discussed more than thirty papers dealing with the various aspects of their departmental problems. Apart from this professional interest in the construction and maintenance of proper roads, the provision of increasing facilities for vehicular and pedestrian traffic must always be of the utmost importance to the general public. The introduction of motors which has initiated new Engineering problems, must produce even a more profound effect upon the social and economic life of the people than the Railways did before, and the greater range and mobility of these mechanically driven vehicles have brought about a transformation in rural India and in the general methods of transport. The basic facts and the elementary governing considerations of road problems are of such vital character as to necessitate the creation of a Ministry of Transport and a Road Research Board financed by the Road Development Account. The need for a Road Research Organisation is evident from two factors, *viz.*, the large amounts annually expended in India on the construction and upkeep of roads, and the large number of accidents associated with motor transport. The traffic problems are not confined to the technical and professional interests of the engineers alone, but they really belong to the domain of an applied science which includes not only Engineering but also Physiology, Psychology and Pedagogy.

The administration of the Road Development Account is vested in the Governor-General in Council in accordance with the advice of the Standing Committee for Roads. It ought to be the function of the Ministry of Transport to administer the Road Fund from which grants have to be made to the Provincial Governments for the maintenance and improvement of public roads, and the Ministry ought to be the responsible government department for initiating measures to promote the safety of road users. It ought to assume responsibility for the approval of all technical details regarding the lay-out and opening of new roads in all schemes for which grants are made from the Road Development Account. It ought to invite the local governments to submit research programmes with special reference to the traffic

and climatic conditions of the provinces, and their practical applications which must be referred to the Road Research Board for investigation and advice. In such a scheme of co-ordination, the problems to be faced by the Ministry can be grouped broadly under two heads, *viz.*, physical and psychological. The former will include materials used in road-making, the processes of construction, road usage and testing apparatus for judging the durability of roads, and the latter must embrace the utilisation of the knowledge and training of applied psychologists in propaganda and instruction of road behaviour. In certain of its major aspects, the division of work in respect of road direction and control, the medical research worker will also find interesting problems. There is a serious responsibility, therefore, for systematising the information regarding all collateral problems upon which can be based the intelligent control and development of road transport in its engineering aspects.

Under the Constitutional Reforms of 1920, the construction and development of roads became a provincial subject. Though in detail the arrangements made by the provincial governments may vary, the general practice is that in some, the more important roads are under the charge of the provincial Public Works Departments, while in others the bulk of the responsibility devolves upon the District Boards or equivalent local bodies. In most provinces there are three authorities in charge of the roads which are classified under the "large trunk roads" and "feeder" roads. Of recent years, the rural problems have assumed a new character owing to the increase in motor transport, and the construction and maintenance of the most important roads have become an All-India concern which the provincial governments have not the financial resources to deal with adequately. The comparative backwardness of the road transport in India may be an advantage to the railways, as serious competition is eliminated, but it must retard the economic development of the country. The roads under the administration of the local bodies acting as affluents to the main arteries, are indescribably bad, and yet they are the main distributive channels of agricultural produce.

With the advent of bituminous and concrete binders, the dust problem may be considered as having been practically solved, but the main investigation is to enquire into the physical and mechanical properties of the heterogeneous materials, subjected to the changing and the increasing intensity of loads and the influence of weather conditions. Strength and deformability as well as processes of attrition and progressive losses of strength, which occur under different conditions in use, must have a specific relation to the intrinsic properties of the various aggregates and to their distribution on the surface. This aspect of road engineering has a peculiar interest to the research worker, more especially in view of the roads being used by vehicles provided with iron and pneumatic rubber tyres.

Asphaltic bitumens, tar and pitch are all extensively used in road work, and our knowledge of the significant chemical properties of all these binders is still imperfect. During the hot weather when the temperature ranges between 100° F. and 120° F. in most districts, tar melts and rises from the surface in soft outcrops sticking to the heels of the bare-footed pedestrians and of the draught animals. The entire surface becomes corrugated on account of the rolling action of the vehicles, causing serious damage to the motor tyres, and when the tarred roads are hard, the ponies which are extensively used for dragging double-wheeled country coaches, slip and break their bones, besides endangering the safety of the occupants. The black surface of the tarred roads makes visibility poor at night, and must account for the numerous motor accidents on such roads at nights. The bulk of pedestrian traffic is bare-footed in India, and what are the effects on the human system of frequenting tarred roads during the greater part of business transactions. The position at present is that the road engineer is employing material brought frequently under trade names, but of whose chemical composition he has no definite knowledge, and whose effect on the users of the road there is no means of ascertaining.

Generally speaking, the Indian roads are a standing menace to public health, acting, as they do, as the great carriers of infectious diseases. It is the common experience in all the Indian towns that the tarred roads during summer emit intense radiation of heat, parching up the air passages of nose and throat, which is a prelude to the onset of influenza and all other manifestation of bronchial and lung trouble. When the hot winds blow over such roads, carrying the dust particles and other impurities, the eyes and mouth of the users of the road become

involuntarily filled with them. In using any new road binders the road engineers and the public health authorities have to co-operate and conduct experimental work before they are employed on a large scale. Roads have always acted as a source of danger to public health, and all attempts at improving its conditions must be supported by a definite knowledge of experimental investigations in the research laboratories.

The most frequent cause of road accidents arises from the skidding characteristics of the surface. We have at present no knowledge regarding the general influence of vehicle design on skidding, and formal investigation in this direction and in its relation to some conditions of road surfaces becoming slippery is desirable as a means of preventing those conditions from arising. Roads accumulate various types of debris on their surface, and behave differently under seasonal and atmospheric conditions and all these have to be linked with the texture and composition of binders. Another factor which produces road accidents is psychological. The statistical data of accidents have been collected in a more or less mechanical fashion, and few psychological tests have been devised to investigate the human factors in accidents. What is the psychological basis of the various traffic regulations? Has the effect of these regulations on the driver and on the pedestrian generally been determined? It must be remembered that the driver of a motor car has to use the eye, the hand and the leg almost simultaneously and does his selection include any examination of how far these organs co-operate in a given situation and how speedily and correctly does his mind form the right judgment? How far does the habitual use of alcohol and narcotics affect the alertness of mind and steadiness of the eye, hand and foot? Equally important with these factors is irritability and impatience, as well as night and colour blindness and defective sight. In such fields of enquiry the psychologists and doctors have to co-operate in the design of traffic and car signals, in the framing of traffic regulations, in the illumination of roads and vehicles and in the selection and rejection of drivers.

Clearly the pedestrian and the cyclist cannot be selected. They are in the habit of picking up their own methods of using the road, and since the traffic regulation is becoming scientific, arbitrary modes of using the road must always produce accidents. It is obvious that they, above all others, should be instructed how to avoid accidents from motor traffic. Instruction in schools and colleges and propaganda by private and aided agencies with a view to impart systematic training may produce the desired results. On the roads it is not uncommon to find the physically deformed and defective people, blind and deaf, old men and unsophisticated children sorely trying the patience of motor drivers, the motor cyclists and bicyclists. We have, on the other hand, villagers carrying headloads, bullock carts carrying steel girders and bamboo poles, and beggars crossing from foot path to foot path, on sighting a car to stop. The Indian traffic conditions are peculiar, and their control and direction must be based partly on research work and partly upon the education and enforcement of traffic regulations.

The importance of scientifically prepared and accident-free roads in India must become evident when it is remembered that more than fifty per cent. of her population uses the road bare-footed almost from infancy to old age, imbibing into the system the dust and pollution of the road accumulations. Will such an existence improve the physical efficiency of the people? It seems to us that the multiplicity of problems involved not only in the construction and maintenance of roads, but also in the reactions of such roads on public health, must be the chief argument in favour of instituting a Ministry of Transport and a Road Research Board.

The Golden Jubilee of H. H. The Aga Khan.

ON January 19th and the four succeeding days the members of the Ismailiah section in collaboration with the other communities organised an elaborate programme fittingly to celebrate the Golden Jubilee of the accession to the Gadi of Imamat of their leader Moulana Hazar Imam His Highness Aga Sultan, Sir Mahommed Shah, G.C.I.E., G.C.S.I. We offer our most sincere and respectful felicitations. The preparations in Bombay were especially noteworthy, for the Khoji community wanted to celebrate the occasion in a manner the world would not easily forget. Unfortunately the news of the death of King George spread a gloom over the Country, and in accordance with the personal wish of H. H. the Aga Khan, only the religious ceremonies were observed. The most striking event of the celebrations was the ceremonial of weighing His Highness against bars of gold in a huge balance to assess the tribute from his followers in honour of the occasion. The practice of weighing against gold is associated with rich historical traditions, and it was a common feature of the royal pageantries in the past. Perhaps the faith in the nobility and incorruptibility of the temporal and spiritual ruler is symbolically represented by gold, whose value is distributed among his followers with his benedictions. His Highness, well known for his piety and people zeal, has desired that the entire amount should be devoted to the spiritual advancement of his followers.

When the history of contemporary events comes to be written, the contributions of H. H. the Aga Khan to the political and social developments of the Empire will occupy a prominent place. It will be recalled that he headed the Muslim deputation in 1906 to Lord Minto to urge the case for the increasing association of the members of the community with the administrative and political life of the Country, and, in its formative stages of development, he guided the destinies of the All-India Muslim League, and initiated a fund for raising the Aligarh College to the University status. Gifted alike with the outlook of an astute statesman and the clear judgment of a critical philosopher, he laboured hard to soothe the Muslim sentiments during the Balkan Wars, and the support and loyalty of his immediate followers during the Great War had a most steadying influence on the community as a whole, when Turkey was drawn into struggle. The influence which His Highness has been exercising on the political life of India is largely reinforced by his intimate knowledge of the trend of the public affairs in Europe, and his personal association with the leading allied statesmen. His study of Indian and Middle Eastern affairs in *India in Transition* (1918) produced a great effect on the final form of the Indian Act of 1919, and was consistent with his criticisms of the British Government's Mesopotamian and Arabian policy. He joined in numerous representatives both at the Peace Conference and subsequently in urging on the importance of preserving the sovereign integrity of Turkey to the interests of Europe generally and of Great Britain in particular. For such distinguished services in the promotion of peace, His Highness on whom the titles G.C.I.E. and G.C.S.I., were already conferred, received the honour of a salute of 11 guns and the rank and status of a First Class Chief of the Bombay Presidency. In 1923 the Council of State recommended him for the Nobel Prize.

His war services were great, but those in the cause of the progress of the Muslim Community are greater. As the guardian of the historical traditions of his race and as one of the chief promoters of the Islamic learning and culture, and as a benefactor of Aligarh University, the Aga Khan is entitled to the lasting gratitude of his community. For his great learning and his disinterested efforts in promoting it, the University of Cambridge conferred on him the LL.D. degree. As India's greatest Muslim leader, and as one of her most respected sons, he will always be remembered in the prayers of all the sections of the Indian population.

Recent Work on the Plant Viruses.

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DURING the past decade the importance of the plant viruses, both from the purely scientific and the economic points of view, has been realised and increasing attention is being paid to their study. In this article a brief account is given of some of the more recent work which, if it does not explain their nature, at least throws some light on certain aspects of the behaviour of these rather mysterious disease agents.

The field of study covered by present-day investigation of viruses is now so vast that it cannot be adequately surveyed in a single article. In order, however, to give the reader a fairly comprehensive statement of the trend of plant virus research, the subject is dealt with in three sections, and in the first of these one or two important points in the relationship of plant viruses with their insect vectors are discussed. In parenthesis it must be stated that the majority of plant viruses are dependent upon certain insects for their spread from diseased to healthy plants in the field and this relationship between insect and virus is one of considerable interest.

It has for long been assumed that the insect was more than a mere mechanical vector of the virus and evidence that supports this view has gradually been accumulating. The existence of an "incubation period" of the virus in the insect or, as it is better called, a delay in the development of infective power, the restriction of the transmitting power for a particular virus to a single insect species, the retention of the virus within the insect for long periods without recourse to a fresh source of infection, are all evidence in favour of there being some kind of obligate relationship between the insect and the virus. Some recent work by Storey[1] has advanced still further the knowledge of insect relationships with viruses. Working with the streak disease of maize and its insect vector, the leafhopper *Cicadulina mbila* Naude, he has shown that there exist two races of this insect, one of which, the *active* race, is able to transmit the virus, the other or *inactive* race, being unable to do so. These two races are identical in appearance and are undoubtedly both of the same species. Furthermore by crossing the pure races Storey has demonstrated that the ability to transmit the streak virus is inherited as a simple dominant Mendelian factor linked with sex. Now comes a further step, the same worker[2] has shown that a simple puncture of the abdomen with a sterile needle, either following or followed by a feed on a diseased plant, sometimes caused inactive individuals of *C. mbila* to become infective. Storey concludes from these observations that in active individuals of *C. mbila* the streak virus, entering the intestine by the mouth, passes through the intestinal wall into the blood; and that, in the inactive insect, the cells of the intestinal wall resist the passage of the virus. It is recognised that there may be some secondary mechanism of resistance; nevertheless in many inactive individuals, once the barrier of the intestinal wall has been passed, the virus behaves as in an active insect. It is of great interest to find that this type of experiment has been repeated by the animal virus workers using the mosquito *Aëdes ægypti* and an eastern strain of the virus of equine encephalomyelitis which this mosquito does not normally transmit. Three separate experiments were made in which the mosquitoes were allowed to feed on infected guinea pigs and half of them were then punctured in the abdomen with a small sewing needle. When the punctured mosquitoes were allowed to feed on normal guinea pigs, infection resulted, whereas the control mosquitoes that had fed on the guinea pigs at the same time but had not been punctured invariably failed to transmit the disease. Apparently this strain of the virus is incapable of penetrating the intestinal mucosa of the mosquito. If, however, it is inoculated into the body cavity by needle puncture it persists and transmission experiments are positive.[3]

An interesting and important point in the relationship between virus and insect is the question whether a virus can be passed

[1] Storey, H. H., *Proc. Roy. Soc.*, B, **1932**, **112**, 46.

[2] Storey, H. H., *Proc. Roy. Soc.*, B, **1933**, **113**, 463.

[3] Merrill, M. H. and TenBroeck, Carl, *J. Exp. Med.*, **1935**, **62**, 687-695.

from an infective parent to the progeny. This question has previously been investigated for several viruses and their insect vectors but always with negative results. In 1934, however, Fukushi[4] published the results of his work on the dwarf disease of rice and its insect vector, the leafhopper *Nephotettix apicalis* Motsch. var *cincticeps* Uhl. The results of these studies seem to indicate that this virus *is* transmitted to a certain percentage of the progeny of infective leafhoppers provided that the *female* of the pair is virus-infected. Progeny from crosses between *uninfective* females and infective males were always free from virus.

There is another and slightly different aspect of the insect relationships with plant viruses which must also be touched upon. This aspect concerns the conditions governing the movement and migration of virus-bearing insects in and about the crops. The work in question has been mainly carried out with the chief insect vector of potato virus diseases, the aphis *Myzus persicæ* Sulz., and experiments have shown that humidity has a definite bearing on the movement of this insect and consequently upon the spread of the viruses. Above a temperature of 55° F. which is approximately the minimum temperature in the potato fields in the British Isles during June and July, a relative humidity of 70 per cent. and above will markedly reduce the instances of flight by *M. persicæ*. At higher temperatures of 80° F. and 90° F., the effect of humidity is even more marked and flight is negligible when the humidity exceeds 85 per cent. This work has an important bearing on the selection of districts suitable for growing good " seed " potatoes. Contrary to the usual assumption, high altitudes with bleak exposed conditions are not necessarily the conditions in which aphides are scarce. Indeed the districts in which low infestations of aphides have been consistently recorded are low-lying, often almost at sea-level.[5]

Before leaving the subject of viruses and their insect vectors, it may be of interest to indicate some of the, as yet, unsolved problems connected with natural mode of transfer of certain viruses. Many readers of this journal will be familiar with the important virus disease of sandalwood known as "spike" and the careful and painstaking efforts of Indian workers to ascertain the insect vector of this virus. Now it appears from a note in *Current Science*[6] that the number of possible vectors is being narrowed down: it has been established that the disease is insect-borne and that the vector is probably a nocturnal insect. At the moment interest is chiefly centred on three types of Pentatomidæ, two types of Jassidæ and three of Fulgoridæ. Similarly, much effort has been expended in attempting to identify the insect vector of potato virus X. This virus is exceedingly common and it undoubtedly spreads in the field; experimental evidence has been obtained of its natural spread from diseased potatoes to healthy potatoes, tobacco, tomatoes and various Solanaceous weeds. Transmission experiments with the normal insect fauna of the potato plant, carried on at Cambridge during the last four or five years, have proved negative with the exception of the work with certain species of Thrips. In all, about twelve apparently positive infections with this type of insect have been obtained in four years out of about two hundred tests. If the Thrips is the vector, therefore, and this is not yet proved, then there must be some other factor necessary for successful experimental transmission which is still to be discovered.

In the second section of this article it is proposed to discuss some of the more important advances made in the study of the virus within the plant. It is now recognised that virus diseases of plants are not necessarily due to the action of a single virus but may be caused by the concerted action of a complex of two or more viruses. As a rule the symptoms caused by two viruses are more severe than the disease due to each virus acting singly. A good example of this is the potato disease known as " crinkle " which is caused by two potato viruses of the X and Y types.[7,8]

Occasionally two viruses may produce a symptom picture which, while slightly different from, is no more severe than, the disease produced by either virus alone. In a case like this it would appear as if one virus

[4] Fukushi, T., *J. Faculty Agric. Hokkaido Imp. Univ.*, Sapporo, Japan, **1934**, **37**, 2.

[5] Davies, W. M., *Ann. Appl. Biol.*, **1935**, **22**, 106-115.

[6] Rangaswami, S., and Sreenivasaya, M., *Curr. Sci.*, **1935**, **4**.

[7] Murphy, P. A., and M'Kay, R., *Sci. Proc. R. Dubl. Soc.*, **1932**, **20**, 227-247.

[8] Smith, Kenneth M., *Proc. Roy. Soc.*, B, **1931**, **109**, 251 267.

cancelled out the other to a slight extent. Again it is possible for a plant to be infected with two viruses but to show symptoms of only one, the second being latent and "carried" without symptoms.

The co-existence of more than one virus in the same plant leads naturally to the question of immunity and this in turn brings up the subject of virus strains. To take the latter subject first, it has been shown that certain viruses of the mosaic group may exist as a number of closely similar strains; this is particularly true of such viruses as those of tobacco mosaic, cucumber mosaic, tomato streak and potato mosaic (virus X). Large numbers of strains of the two first mentioned viruses have been isolated and some of these strains, while having the same general properties, yet may produce entirely different symptoms on similar host plants. This fact of course adds greatly to the difficulties of the identification and classification of plant viruses. Next, as regards immunity, it has been discovered that a plant which is infected with one strain of a mosaic virus is protected from further infection with another strain of the same virus, no matter how different the respective symptom pictures of the two strains may be. On the other hand several strains of the same virus will enter the same host plant if inoculated simultaneously. There is apparently no question of antibody formation in the plant involved; this non-sterile type of immunity depends entirely upon the systemic presence of the virus which entered the plant first. If this first virus is not systemic in the plant, then the second strain may enter those cells which are still free of the first strain.[9,10] It must be understood that this immunity is specific for like viruses and virus strains only; there is no cross-immunity conferred upon a plant against cucumber mosaic, for example, by a previous infection with tobacco mosaic. Here then, the reader will realize, is a useful means of differentiating between different viruses and virus strains and this method is particularly applicable in identifying the virus of cucumber mosaic which affects a large number of ornamental and other plants. A bright "yellow" strain of cucumber mosaic producing unmistakeable symptoms can be inoculated to the plants which are suspected of infection with the ordinary "green" strain of the virus.

The question of the origin of these different strains is an interesting one; do they arise by some mutation process during the inoculations or are they there all the time and are merely being selected out in the serial transfers of the virus? On the whole the evidence is in favour of the theory that new strains arise during inoculation studies[11] and some circumstantial evidence for this view is also available from a consideration of virus complexes as they occur naturally in the field. The following example will perhaps make this point clearer, potato plants are frequently found in the field affected with several strains of the mosaic virus known as X. Now it has been shown that plants infected with one strain of this virus are immune to attack by other strains,[12] therefore it must be assumed in such a case either that the virus X has mutated while in the plant or that these various strains were introduced simultaneously into the plant by one insect vector which seems unlikely.

The recognition that certain viruses produce necrotic spots or local lesions on the inoculated leaf has led to the development of a technique for the more accurate quantitative study of plant viruses. The use of local lesions allows the recognition of large numbers of successful transmissions on single plants and makes possible comparative estimates of virus concentrations. At high concentrations of the virus there is no direct and simple relationship between virus concentration and the number of lesions produced but it is possible within certain limits to tell which of two samples of virus is the more concentrated.[13] In carrying out experiments of this nature it is important to adopt a standard method of inoculation and to compare the virus samples on opposite halves of the same leaves. This is done in order to eliminate as far as possible the effects of variation in susceptibility. The kind and degree of this variation have been examined by statistical analysis and the data submitted to reduction by the analysis of variance. Plants differ greatly in their reaction to inoculation and a gradient of susceptibility was established between the different leaf positions. It was shown that

[9] Kunkel, L. O., *Phytopath.*, **1934, 24,** 437-466.

[10] Price, W. C., *Phytopath.*, **1934, 24,** 743-761.

[11] Jensen, J. H., *Phytopath.*, **1933, 23,** 964-974.

[12] Salaman, R. N., *Nature*, **1933, 131,** 468.

[13] Caldwell, J., *Ann. Appl. Biol.*, **1933, 20,** 100–116.

the right and left halves of a leaf responded equally to inoculation procedure. [14,15]

The subject of the cultivation *in vitro* of both plant and animal viruses is one which has claimed the attention of many workers. Upto the present no one has succeeded in growing a plant virus in an artificial cell-free medium and opinion seems to be divided as to whether this has been accomplished with any of the animal viruses. On the other hand several animal viruses have been grown in tissue culture or in media containing fragments of tissue and the virus of influenza is the latest addition to the animal viruses thus successfully cultivated.[16] For a recent review of the situation in regard to the *in vitro* cultivation of filterable viruses the reader is referred to a paper by G. Hardy Eagles.[17]

So far as the plant viruses are concerned, it has recently been shown that the virus of tobacco mosaic can be cultured for indefinite periods in the growing excised tips of tomato roots in a nutritive liquid. There are two rather interesting points which may be mentioned in connection with this method of virus cultivation. First it has not been found possible to inoculate the virus directly into the roots. The tomato plant itself must be inoculated and when the virus has reached the roots, the tips of these can then be cut off and cultured with the virus already within them. The second point is the absence of all symptoms in the virus-containing roots and this may be due to lack of chlorophyll in the roots since the disease symptoms characteristic of virus attack appear to be due to the destructive effect of the virus on the chlorophyll apparatus.[18]

Reference to the existence of viruses in the roots of plants recalls the recent discovery of a rather mysterious virus which is found in the roots of perfectly normal plants belonging to the Solanaceæ and other families. The questions of where this virus comes from and how it gets into the roots of the plants constitute some of the most interesting problems in plant virus research.[19]

[14] Samuel, G., and Bald, J. G., *Ann. Appl. Biol.*, **1933**, **20**, 70-99.
[15] Youden, W. J. and Beale, Helen Purdy, *Contrib. Boyce Thomp. Instit.*, **1934**, **6**, 437-454.
[16] Wilson Smith, *Brit. J. Exp. Path.*, **1935**, **16**, 508-512.
[17] Eagles, G. Hardy, *Biol. Rev.*, **1933**, **8**, 335-344.
[18] White, P. R., *Phytopath.*, **1934**, **24**, 1003-1011.
[19] Smith, Kenneth, M., *Nature*, **1935**, **136**, 395-396.

The third section of this article is concerned with some aspects of the study of the virus outside the host plant. Improved methods for the ultrafiltration of viruses have been devised by Elford[20] who has developed a technique for the preparation of collodion membranes of uniform and graded pore size. By the passage of viruses through these membranes it is possible to calculate the particle-size of such viruses with considerable accuracy and this technique has now been applied in the measurement of the particle-size of a number of animal and plant viruses. The following are the approximate particle diameters of a few plant viruses as measured by this method; potato virus X, 80-120 $m\mu$, tobacco necrosis virus 20–30 $m\mu$, a new tomato virus 17–25 $m\mu$.*

For a proper study of the virus itself, not only from the point of view of ultrafiltration but also from other aspects, it is important that the virus suspension should be freed from as much of the extraneous matter present in plant sap as possible, and the purification of plant virus suspensions therefore forms a very important part of virus research. Stanley[21] working at the Rockefeller Institute in Princeton states that he has purified the virus of tobacco mosaic until he has produced a crystalline material having all the properties of that virus. Stanley inclines to the view that the virus of tobacco mosaic is an autocatalytic protein rather than a living organism.

The effect of enzymes upon viruses is interesting and important as being likely to throw light on the nature of these agents. First as regards the virus of tobacco mosaic and its reactions with trypsin; although inactivation is produced by this enzyme it is considered for the following reasons to be due partly to a virus inhibitory effect of the enzyme upon the test plant rather than upon the virus itself.[22] The loss of infectivity is immediate without time being necessary for the digestive action of the trypsin upon the virus. Again, the loss of infectivity is produced over a wide range of hydrogen-ion concentrations including some at which trypsin is proteolytically inactive. Lastly, the infectivity of the virus may be regained by heat, by dilution or by digestion and removal of the trypsin.

[20] Elford, W. J., *J. Path. and Bact.*, **1931**, **34**, 505.
* 1 $m\mu$ equals one millionth of a millimetre.
[21] Stanley, W. M., *Science*, **1935**, **81**, 644-645.
[22] Stanley, W. M., *Phytopath.*, **1934**, **24**, 1055-1085.

Pepsin inactivates the virus of tobacco mosaic at pH 3 at a temperature of 37° C. and the rate of inactivation of the virus varies directly with the concentration of active pepsin. This suggests that the inactivation of the virus is due to the proteolytic action of pepsin and that the virus is therefore either a protein or very closely associated with a protein.[23]

The reactions of potato virus X with enzymes have also been studied.[24] Trypsin appears to have two distinct effects on this virus, one an immediate loss of infectivity and the other a loss of infectivity only after incubation. The fact that the immediate action of trypsin does not affect the flocculation of virus X suspensions with antiserum, whilst on incubation the serological reactions become progressively weaker, is an indication that the effects on mixing and on incubation are qualitatively different.

In the presence of pepsin as in the presence of trypsin, tobacco mosaic virus and potato virus X behave differently. As mentioned above[22], 0·17 per cent. crystalline pepsin slowly inactivates tobacco mosaic virus at pH 3 and 37° C. Virus X, on the other hand, was completely inactivated by a 0·2 per cent. solution of crystalline pepsin in 3 hours at pH 4 and 38° C. Papain alone and cyanide alone had no effect on virus X but the two together inactivated it. This fact is considered to be highly suggestive that virus X contains protein.[24]

Finally, a new and important study, the antigenicity of plant viruses, must be briefly discussed. It has been shown by a number of investigators that antibodies reacting specifically with the sap of certain virus-infected plants can be produced by the intraperitoneal injection of rabbits with such expressed saps. The resulting *antibody*, appearing in the blood serum or body fluids of the hyperimmunized animal, reacts with the *antigen* (plant virus) in some observable way. Three types of reaction have been considered, complement fixation, precipitation and neutralization of the pathogenic properties of the virus. The following facts have now been elucidated by different workers on the serological reactions of plant viruses. The immunization of rabbits with plant virus extracts produces sera which specifically and quantitatively neutralize the viruses concerned.[25] If the virus suspension be filtered through a series of graded collodion membranes the precipitin reaction is only given by that fraction of the filtrate containing the virus. In other words, if the pores of the membrane are too fine to allow passage of the virus, then the filtrate gives no precipitin reaction. The precipitin and complement-fixation reactions are approximately proportional in strength to the quantity of virus present in the sample. These results seem sufficient to show that the antigen causing these serological reactions is the virus itself and not normal constituents of the plant sap.[26]

What then are the practical applications of this technique in the study of plant viruses? First, a delicate test is available for the identification of a virus since the serological reactions are specific for viruses and virus strains. Secondly, the technique can be used as a rapid and accurate means of determining the relative virus content of infective samples and further it is suggested[27] that the antisera afford a method for arriving at a reliable estimate of the total virus in a mixture of strains where the results of virus estimation by counting local lesions on leaves would be misleading. This applies more particularly to a mixture of two or three strains of potato virus X, some of which strains produce no local lesions on inoculated leaves.[28] The attempt has also been made to estimate serologically the absolute concentration of tobacco mosaic virus.[29]

After reading this short article some idea will have been obtained of the activity among present-day virus workers and also of the ramifications of this branch of study into the physical and chemical as well as the biological domains. The collaboration of physicists, chemists, plant pathologists and botanists in approaching this problem is to be welcomed, for only by such team work will the answer finally be obtained to the question—What is a virus?

[23] Stanley, W. M., *Phytopath.*, 1934, **24**, 1269-1289.

[24] Bawden, F. C., and Pirie, N. W. (1936, in the Press).

[25] Chester, K. S., *Phytopath.*, 1934, **24**, 1180-1202.

[26] Chester, K.S., *Phytopath.*, 1935, **25**, 702-714.

[27] Bawden, F. C., *Brit. J. Exp. Path.*, 1935, **16**, 435.

[28] Spooner, E. T. C. and Bawden, F. C., *Brit. J. Exp. Path.*, 1935, **16**, 218.

[29] Chester, K.S., *Science*, N. S., 1935, **82**, 17.

Crystalline Structure and Physico-Chemical Properties in the Colloidal State.

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AS a result of the interesting investigations of P. P. Von Weimarn,[1] Graham's classification of matter into crystalloids and colloids has come into disfavour and it is now admitted on all hands that matter in a particular state of sub-division will in general exhibit colloidal properties. Thus the rôle of sizes in colloidal solutions cannot be over-emphasised as the colour and some of the most important surface properties such as adsorption are to a large extent function of the particle size. One is, however, apt to forget that in such particle sizes as constitute the colloidal state the surface reactivity is also considerably increased and there are rarely, if ever, colloidal particles which are chemically pure. Most hydrophilic colloids are hydrated in water, while the hydrophobic ones get a surface coating of oxides and sub-oxides or form complex solid solutions, while the organosols of metals obtained by arcing even by high frequency and low amperage currents at very low temperatures are seldom free from carbonised matter produced during arcing. The purity of the metal employed is thus in no way a criterion of the chemical purity of the resulting colloidal solution. Even a noble metal like platinum when in a colloidal state has been shown by Pennycuick[2] to be contaminated with PtO_2 and oxy-acids.

These films of impurities considerably mask the properties of the metals themselves and many of the reported changes of colour and other physical properties in colloidal solutions are due to the kinds of impurities occluded with the colloids or the influence of the solvent and oxygen on the fine-grained material. As a classical example of this may be cited the interesting work of Kohlschutter[3] on the silver sols. These sols when prepared in Thuriangian and Jena glass vessels differ in colour; those in Thuriangian glass are yellowish brown to rose red and those in Jena glass reddish violet to dark blue. It was definitely shown that this difference in colour was neither due to the sizes nor to the constituents of the walls of the vessels appreciably entering into the constitution of the micellæ, but was solely due to a different content of Ag_2O determined by the adsorption relationship on the walls. The accurate estimation of Ag and Ag_2O completely established this view.[4] Besides colour, other physical properties such as density, magnetic susceptibility, electrical conductivity and solubility undergo profound changes in the colloidal state for similar reasons and when these impurities are removed chemically or physically the system shows a return to original properties. It is, however, quite conceivable that in the process of colloidalisation or crystallisation the system may undergo more profound changes, for example, a change in the crystal structure or an allotropic modification may take place owing to large pressures and temperatures developed during grinding or arcing or to some other causes such as action of light depending upon the specific properties of the material itself. When this happens, the physical or chemical removal of the film is incapable of completely restoring original properties of the system. This change is then really akin to an allotropic transformation and the new properties acquired are then not a function of the particle size but of the new crystal or molecular structure. This difference is of fundamental importance and has been ignored by many workers while accounting for changes observed in colloidalisation and crystallisation. The changes noticed are due not to particle sizes but to a definite change in crystal structure. One may recall here the famous controversy regarding the yellow and red oxides of lead. The earlier work of Ditte,[5] Geuther[6] and Ruer,[7] etc., showed that the two forms were clearly distinguishable from each other. Glasstone,[8] however, concluded that this difference in colour is due only to the different states of aggregation of the particles. But the later and

[1] *Grundzuge der Dispersoidchemie*, T. Steinkopf, Leipzig, 1911.
[2] *Jour. Amer. Chem. Soc.*, 1930, **52**, 4621.
[3] *Zeit. f. Electrochemie*, 1908, **14**, 49.
[4] Freundlich, *Colloid and Capillary Chemistry*, 1926 Ed. pp. 374-375.
[5] *Compt. Rend.*, 1882, **94**, 1310.
[6] *Ann. der Chemie.*, 1883, **219**, 56.
[7] *Zeit. anorg. Chem.*, 1906, **50**, 265.
[8] *Jour. Chem. Soc.*, 1921, **119**, 1689 and 1914.

more careful work by Applebey and Reid[9] has definitely shown that Glasstone's conclusions are not justified and the two forms are structurally different, the crystalline and optical characteristics of the red oxide being tetragonal, uniaxial and negative and those of the yellow variety rhombic, biaxial and positive. Kohlschutter and Scherrer[10] confirmed the difference in crystal structure by the X-ray method. Their specific diamagnetic susceptibilities are also different, the red variety having a value of $\chi = -0{\cdot}211 \times 10^{-6}$ as against $\chi = -0{\cdot}196 \times 10^{-6}$ for the yellow variety.[11]

Another interesting case is that of the red and the yellow oxides of mercury where R .N. Mathur reports that the magnetic susceptibilities are identical $(-0{\cdot}243 - 4 \times 10^{-6})$ in both cases which suggests the same crystal structure in both cases. This evidence is beautifully corroborated by Levi,[12] Fricke[13] and Zschariasen[14] who have attributed the colour to particle size as they find that the two oxides are crystallographically identical.

From these observations it is abundantly clear that there are certain physical properties such as colour which may be influenced both by crystal structure as well as particle size. There are other properties such as magnetic susceptibilities which are influenced only by change in the crystal structure or by occluded impurities and do not seem to be much influenced by particle size. The reported changes of magnetic susceptibilities by cold working by Honda and Shimizu[15] in case of copper and tin can be satisfactorily accounted for on the view that in cold working the crystalline structure undergoes modification. This view has found general support by all workers in physics.

If the forces employed or generated in powdering or colloidalisation are capable of inducing a change in crystal structure, the colloid is likely to show variation in magnetic susceptibilities even after the adsorbed film has been removed, but if the powdering has only changed the particle size and not the crystal structure, the mere sizes will produce no difference in the value of χ when the entrained impurities have been washed away.

It looks to the writer that many old controversies regarding the behaviour of colloids can be reviewed in the light of the above observations. For example, Weigert[16] advocates the view that the stream double refraction in colloidal solutions is dependent upon the size of particles and the distance between them and occurs only when both the particles and the distance between them are amicronic. Against this view is the evidence cited by Freundlich[17] depending on the close relationship between this double refraction and the age of certain sols and the change in ultramicroscopic appearance and structure with age. These changes strongly support the view that the birefringence in such colloids is an intrinsic and not a mere rod double refraction. The X-ray method has also established that changes in crystalline structure on powdering may take place occasionally[18] and the differences in physical and chemical properties obtained in some cases are a function not of the particle size but of crystal structure.

An examination of some of the physical properties of colloidal system such as the peizo-electrical behaviour in gels and the thermal and electrical conductivities of sols and gels will lead to important results particularly in systems where the colloidal state is accompanied by a change in crystal structure. As a matter of fact a complete review of properties of colloidal systems on this view may be well worth-while.

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[9] *Jour. Chem. Soc.*, 1922, **121**, 2129.

[10] *Helv. Chim. Acta*, 1924, **7**, 337.

[11] *Cf.* R. N. Mathur, Thesis for the D.SC. Degree, Punjab University.

[12] *Gazz. Chim. Ital.*, 1924, **54**, 709.

[13] *Zeit. anorg. Allgem. Chem.*, 1927, **168**, 244.

[14] *Zeit. physikal Chemie*, 1927, **128**, 421.

[15] *Nature*, 1930, **126**, 990; 1935, **135**, 108.

[16] *Cf.* Weigert and Pohle, *Kolloid Zeit.*, 1921, **28**, 153.

[17] Freundlich, *Colloid and Capillary Chemistry*, 1926 Ed., pp. 404 and 411.

[18] Asahara, *Scientific Papers, Inst. Phys. and Chem. Research, Tokyo*, 1922, **1**, 23.

Magnetic Properties of Colloidal Powders of Metallic Elements.

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1. INTRODUCTION.

IT is the object of this paper to present a critical survey of the experiments which have been conducted to study the dependence of magnetic properties of colloidal particles of metallic elements on their dimensions.

Honda[1] discovered that colloidal suspensions of gold in water prepared by the Bredig method possessed a smaller diamagnetism than the mass metal, but there is very little doubt that the suspension was partly a hydroxide. The problem of the high diamagnetism of bismuth had always been a puzzle and Ehrenfest[2] suggested that if we contemplate the valency electrons to possess large orbits encircling a number of atoms, the anomaly may be explained. This theory was extended by Raman[3] to the case of graphite. In support of these conclusions, Paramasivan[4] showed that the diamagnetic susceptibility of graphite depends on particle size. Vaidyanathan[5] confirmed this result in the case of graphite and obtained similar results with bismuth and antimony. Bhatnagar[6] and his collaborators[7] have maintained the view that such decrease is due to chemical action. Some points of view both from the direction of experiment and from theory are presented to show that the dependence of diamagnetism on particle size is genuine.

The problem of the magnetic properties of metals has been complicated. A few general conclusions have, however, been definitely established. A metal can be considered to be built up of a lattice of metallic ions, the remaining electrons of the atoms being considered free or partly bound in accordance with their energy values. The susceptibility of the metal (non-ferromagnetic of course), is the sum of the susceptibility of the ion and that of the extra-ionic electrons. The first component is constant for a given ion while the latter part is structure sensitive and is dependent on the several physical conditions of the metal under investigation.

A point of great significance now emerges from these considerations. The contribution to the susceptibility made by the extra ionic or the valency electrons depends on the nature of their binding. We may postulate in a general manner three types of binding so far as metallic elements are concerned. In the homopolar type of binding, the susceptibility of the crystal is approximately equal to the sum of the susceptibility of the atoms, as for example, in the case of grey tin. In the metallic type of binding, the electrons are considered to be mobile and shared by the whole crystal. By Pauli's theory,[8] such electrons will contribute a paramagnetic component given by

$$(\chi_A)_e \times 10^6 = 48{\cdot}17q/V_0[1-6{\cdot}113\times10^{-9}(T/V_0)^2]$$

where q is the number of free electrons per atom, V_0 is the width of the energy band occupied by the electrons in volts and T the absolute temperature. Superposed over this, there is the Landau[9] diamagnetism equal to one-third of the Pauli paramagnetism. In the third type of binding, we assume with Raman and Ehrenfest that the valency electrons have large orbits, encircling a relatively large number of atoms. A distinction is thus sought to be established between the ordinary homopolar binding in metals and the Ehrenfest-Raman binding. It is now easy to realise that in a metallic crystal some of the valency electrons may possess one type of binding and the others another type of binding. We may cite the case of thallium crystals in which the two valency electrons having their orbits in the hexagonal plane possess a homopolar binding while the third valency electron may be considered as free.[10] In the case of graphite[11] (though not a metal) we have abundant evidence to show that the binding

[1] *Ann. der Phys.*, 1910, **32**, 1027.
[2] *Physica*, 1929, **5**, 388.
[3] *Nature*, 1929, **123**, 945.
[4] *Ind. Jour. Phys.*, 1929, **4**, 139.
[5] *Nature*, 1929, **124**, 762, and 1930, **125**, 820. Also *Ind. Jour. Phys.*, 1930, **5**, 559.
[6] *Ind. Chem. Soc. Jour.*, 1930, **7**, 975.
[7] *Ind. Jour. Phys.*, 1931, **6**, 181; *Ind. Chem. Soc. Jour.*, 1933, **10**, 321; *Curr. Sci.*, 1935, **3**, 611.
[8] Stoner, *Magnetism and Matter*, p. 501.
[9] *Zeits. f. Phys.*, 1930, **64**, 629.
[10] Under publication in the *Phil. Mag.*
[11] *Phil. Trans.*, 1933, **231**, 235.

in the hexagonal plane is of the Ehrenfest-Raman type while in the hexagonal plane it is probably metallic.

2. EHRENFEST-RAMAN BINDING.

It is now easy to follow the effect of colloidalisation on the magnetic susceptibility of elements. The large Ehrenfest-Raman orbits are not possible on the surface of crystals and hence increase of surface area by fine powdering would bring about a decrease in the specific diamagnetic susceptibility. This explanation implies also that the particles are much less densely packed on the surface than in the interior. In support of this conclusion, we have the case of graphite for which it has been shown that the interatomic distance increases at small particle sizes.[12] Thus in those elements like graphite, bismuth and antimony which exhibit large diamagnetism, probably because of large valency orbits, experiments have definitely proved the existence of rapidly decreasing susceptibility at particle sizes less than about $1 \cdot 4 \times 10^{-4}$ cm.[13] That adsorbed layers of gases or chemical actions were not responsible for the observed decrease of susceptibility was conclusively verified in the case of bismuth by showing that the crystal diamagnetism was restored on melting the powder *in vacuo* and cooling.[14]

Graphite colloids were initially studied by Paramasivan, Vaidyanathan and the author. Miwo[15] in Japan studied the susceptibility of different forms of carbon and found that the magnetic susceptibility was proportional to the grain size in the range of amorphous carbon. He thus confirmed the influence of particle size at diameters much smaller than $0 \cdot 15 \times 10^{-4}$, the lowest size reached by the author. Goetz[16] has investigated the magnetic properties of fine graphite particles by producing suspensions of crystalline powders in which these particles were all fixed in a crystallographically parallel position to each other. By this ingenious method, he confirmed the following observations: (*a*) that for particles having diameters above 5×10^{-4} cm., the diamagnetism was independent of particle size, (*b*) that a sudden decrease of the diamagnetic susceptibility occurred at particle sizes below the critical diameter of $1 \cdot 5 \times 10^{-4}$ cm. He has also reported similar results for bismuth and antimony.[17]

The author[18] first drew attention to the possibility of a connection between the critical diameter of $1 \cdot 5 \times 10^{-4}$ cm. for bismuth and the value of $1 \cdot 4 \times 10^{-4}$ cm. obtained by Goetz for the side of the elementary pyramid as observed on freshly-etched surfaces. He also suggested that this coincidence may lend support to the theory of secondary structure proposed by Zwicky. Although this theory has been vigorously criticiscd,[19] it seems to the author that in a slightly different form as perhaps suggested by Goetz,[20] it may carry greater significance. In fact it is not unlikely that the Raman-Ehrenfest orbits themselves may be responsible for the existence of small blocks in crystals which exhibit high diamagnetism.

Attention may also be drawn to the recent work of Prins[21] who finds for colloidal antimony a diamagnetic susceptibility smaller than for the mass metal. He suggests that in the amorphous state, the metal exists almost like a liquid, *i.e.*, without the Ehrenfest-Raman orbits. This is a striking result which amply confirms our general conclusions.

Lane[22] investigated the diamagnetic susceptibilities of thin films of bismuth and reported no deviation in the range of thickness between $0 \cdot 2\,\mu$ and $15\,\mu$. The author[23] drew attention to the fact that in such experiments the calculated thickness would never give the actual dimensions of the particles and showed that no variation was therefore to be expected. At the same time Goetz[24] reported the same conclusions and mentioned that his experiments with bismuth supported the dependence of diamagnetism on particle size.

Another important direction in which support can be adduced is by introducing foreign atoms into the elements like bismuth

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[12] Randall, *Diffraction of X-rays*, 1934, 192.

[13] *Ind. Jour. Phys.*, 1931, **6**, 241.

[14] *Ind. Jour. Phys.*, 1932, **7**, 35.

[15] *Sc. Rep. Tohoku Imp. Univ.*, 1934, **23**, 242.

[16] *Phys. Rev.*, 1932, **39**, 169 and 553; 1932, **40**, 1053; 1934, **45**, 282.

[17] *Phys. Rev.*, 1934, **45**, 293.

[18] Ref. 14.

[19] International Conference on Physics, *The Solid State of Matter*, 1934, pp. 57-139.

[20] Ref. 19, pp. 62-72.

[21] *Nature*, 1935, **136**, 299.

[22] *Nature*, 1932, **130**, 999.

[23] *Nature*, 1933, **132**, 207.

[24] *Nature*, 1933, **132**, 206.

and graphite. Krishnan and Ganguli[25] showed that by the absorption of oxygen atoms between the carbon layers, the abnormal susceptibility along the c axis is almost completely destroyed while the value remains the same along the basal plane. Equally interesting are the observations of Goetz and his collaborators.[26] By dissolving small quantities of foreign atoms, it was found that there was a definite critical concentration of the foreign atoms in bismuth, below which the specific effect of the impurity was 10 to 100 times larger than above. This was interpreted as indicating that below the critical concentration, the foreign atoms produced surface effects by getting between the boundaries of groups of atoms within the crystal. These remarkable results lend strong support to the conclusion regarding the dependence of diamagnetism on particle size. It is interesting to draw attention to the observation made by Focke[27] who observed the cleavage plane of a crystal of bismuth infected with polonium while molten and subsequently cooled, with a Geiger counter. He showed that the Po atoms arranged themselves in planes separated by a distance of $0{\cdot}6 \pm 0{\cdot}1\,\mu$ which coincides very well with the spacing obtained for the 111 planes by Goetz[28] by microscopic observations.

Some investigators[29] have mentioned that the observed changes of the susceptibility at small particle sizes may be due to ferromagnetic impurities crystallising out on colloidalisation and thus offering a larger positive susceptibility component, in the manner suggested by Kussman and Seeman.[30] But careful experiments conducted by the writer do not show any evidence of such influence since no changes are observed as the measurements are made at large field strengths.

3. Metallic Binding.

We shall now consider the case of metals wherein the binding is of the metallic type. Such metals are good conductors. The valency electrons may here be considered as free, the number of such electrons being of the same order as the number of atoms in the metal. Honda and Shimizu[31] have discussed the problem of cold working and shown that the diamagnetism increases in the case of copper and silver. They have accounted for this result as being due (1) to the Pauli decrease in the paramagnetic component due to the diminution of free electrons caused by the expansion on cold-working[32] (for which evidence is available from X-ray data[33]) and (2) the increase in the diamagnetic component due to the increased number of bound electrons.[34] Honda and Shimizu thus showed that there should be a net increase in the diamagnetic susceptibility on cold-working. A point of great importance is that proper corrections should be applied for the presence of ferromagnetic impurities and any such omission will lead to confusing results as were initially obtained by Honda and Shimizu[25] and also by Bitter[36] and Lowance and Constant.[37] More recently Honda and Shimizu[38] have applied these considerations to the problem of liquefaction and accounted for the observed changes in the case of few metals. They have also drawn attention to the close relation between colloidalisation and cold-working and suggested that on colloidalisation there is decreased density on the surface of the particles and consequently an increased diamagnetic component. These conclusions are abundantly verified in the case of tin and copper by the writer.

The case of tin is of special interest.[39] White tin has a paramagnetic susceptibility of 0·036 (all susceptibility values are given in 10^{-6} units) while in the powder state the susceptibility becomes diamagnetic approaching the value of 0·30 being the value of grey tin. The binding which is metallic in white tin becomes homopolar in grey tin and consequently we have the restoration of the atomic value for tin as the metallic linkages are removed. It is also well known that the conductivity of white tin is much larger than that for grey tin. On melting the powders in vacuum and cooling, the value

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25 *Curr. Sci.*, 1935, **3**, 472.
26 *Phys. Rev.*, 1934, **45**, 170.
27 *Phys. Rev.*, 1934, **45**, 219; 1934, **46**, 623.
28 Ref 20.
29 Ref. 22.
30 *Naturwis.*, 1931, **19**, 309.
31 *Nature*, 1933, **132**, 565.
32 *Zeits. f. Phys.*, 1927, **41**, 99; 1930, **64**, 629; 1932, **75**, 809.
33 *Phil. Mag.*, 1934, **18**, 495.
34 *Zeits. f. Phys.*, 1932. **78**, 283.
35 *Nature*, 1931, **127**, 556.
36 *Phys. Rev.*, 1930, **36**, 978.
37 *Phys. Rev.*, 1931, **38**, 1547.
38 *Nature*, 1935, **135**, 108; 1935, **136**, 393.
39 *Proc. Ind. Acad. Sci.*, 1935, **1**, 123.

for white tin was restored. It is interesting in this connection to note that the critical diameter below which the susceptibility changes rapidly is $2 \cdot 0 \mu$ for tin. Since these results were reported the author has come across a statement of Desch[40] that a dodecahedral face of a tin crystal gives long parallel ridges on etching and that these ridges are crossed by markings approximately 2μ apart.

Similarly on colloidalisation by condensed electrical discharge in an inert liquid in the absence of air, copper showed an increased diamagnetic susceptibility.[41] The behaviour is quite similar to what is observed when this metal is subjected to cold-working. The critical diameter below which large changes were observed was $0 \cdot 8 \mu$ being much smaller than the corresponding values for bismuth, graphite and tin. Honda and Shimizu's theory will suggest that the density of the metal on the surface layer of the particles should be much less than in the interior. An approximate calculation indicates that the thickness of this surface layer is probably 300 A.U. and its diamagnetic susceptibility 0·200. This will mean that the density of the surface layer is 8·404 as against 8·943 for the mass metal. It is likely that the observation of G. P. Thompson[42] that electrolytically deposited copper on the etched surface of a copper crystal has a higher spacing than ordinary copper as determined by electron diffraction methods is borne out by fact.

Vaidyanathan[43] worked with gold and silver particles prepared by the method of Zsigmondy but his deduction is uncertain since he compares his colloidal values with those given for the mass metals in the *International Critical Tables*, particularly when it is remembered that different investigators have given different values even for the same metal.

4. Homopolar Binding.

In the light of the foregoing discussion it is apparent that in the case of metals wherein the binding is predominantly homopolar, colloidalisation will not result in any appreciable change in susceptibility. The results that have been observed with selenium are difficult to understand.[44]

[40] Ref. 19, p. 109.
[41] *Proc. Ind. Acad. Sci.*, 1935, **2**, 249.
[42] *Proc. Roy. Soc.*, 1931, **133**, 1.
[43] *Nature*, 1931, **128**, 302.
[44] *Nature*, 1934, **134**, 497.

5. Ferromagnetic Metals.

The ferromagnetic metals stand on a different basis altogether. Heisenberg's[45] theory presupposes the existence of micro-crystals within the crystal, the resultant spins of these micro-crystal having random orientations which compensate each other in the absence of an external field. Bitter's[46] model for a ferromagnetic body based on the block structure theory of Zwicky, consists of micro-crystals each of these containing about 10^5 atoms. On colloidalisation, a large number of such micro-crystals may suffer disruption on the surface of the particle and these broken ones may not give rise to any ferromagnetic intensity since the blocks are not complete for an internal field.

Montgomery[47] showed that fine particles of nickel produced by an electrical dispersion method in an inert liquid in the absence of air had a smaller intensity of magnetisation than the mass metal. These experiments were repeated in a slightly different manner by the author and his results were confirmed. Support for this point of view may also be had from the investigations on thin films of nickel. Langmuir,[48] Steinberg,[49] Sorensen,[50] Wait,[51] Howey[52] and others showed that the films prepared by depositing nickel vapour on a cool surface really consisted of minute crystal grains, too small to be distinguished in a microscope. Ingersoll and De Vinney[53] obtained almost non-magnetic films of nickel by depositing the metal on a cold surface. On heating the film the usual magnetic value was obtained probably because of recrystallisation. More experiments with ferromagnetic metals are necessary to establish these conclusions with certainty.

Abstract.

A critical account is presented of the investigations on the magnetic properties of colloidal powders of metals. Three types of binding of the valency electrons in metals are contemplated: (1) metallic,

[45] *Zeits. f. Phys.*, 1928, **49**, 619.
[46] *Phys. Rev.*, 1931, **37**, 90.
[47] *Phys. Rev.*, 1932, **39**, 163.
[48] *J. Am. Chem. Soc.*, 1916, **38**, 2221.
[49] *Phys. Rev.*, 1923, **21**, 22.
[50] *Phys. Rev.*, 1924, **24**, 658.
[51] *Phys. Rev.*, 1922, **19**, 615.
[52] *Phys. Rev.*, 1929, **34**, 1440.
[53] *Phys. Rev.*, 1925, **26**, 86; see also *Phys. Rev.*, 1929, **34**, 972.

(2) homopolar and (3) Ehrenfest-Raman. The influence of colloidalisation on the magnetic properties of metals in which these types of binding are present is mentioned. Attention is drawn to the experiments by Goetz on the effect of small quantities of foreign metals in bismuth crystals. The close analogy between colloidalisation and cold-working in the case of metals wherein the metallic type of binding is predominant, is considered in the light of Honda and Shimizu's theory. Brief mention is made of the investigations on nickel powders and films in the light of Heisenberg's theory.

The Chemistry of Antimalarials.

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THE toll of malaria in India and other parts of the world is increasing day by day. Malaria is described as a great, if not the greatest, obstacle to the physical, intellectual and economic progress of the people, the enormous mortality and labour inefficiency caused by this disease being a matter of dismay. The seriousness of the epidemic that raged last year in Ceylon may be realised from the fact that 74,000 deaths were caused by this disease during six months. The situation afforded an opportunity to test on a mass scale the value of quinine and of synthetic antimalarial drugs and the report thereon should prove of great value. In view of the fact that malaria causes an enormous waste of human efficiency, any well-planned chemical investigation undertaken as a campaign against malaria will indeed prove a beneficent factor in the amelioration of human distress and in the promotion of international welfare.

For the last half-century, quinine has been considered pre-eminently effective in the treatment of malaria and the selective cultivation of cinchona, in India and Java, has aimed at a maximum yield of quinine. Cinchona bark contains some twenty alkaloids. It is becoming increasingly clear, however, that several other alkaloids are at least as potent as quinine and instead of the expensive pure quinine, the crude mixed cinchona alkaloids are now being used. A comparative examination[1] of specially purified specimens of the principal cinchona alkaloids and their dihydro bases, has revealed that dihydroquinine is more active and that dihydroquinidine, cinchonidine and quinidine are less active than quinine. Our knowledge as to what particular group of the quinine molecule is responsible for its pronounced physiological activity is far from complete, for other alkaloids are known which show a similar physiological activity without possessing the various features of its constitution. Quinine has not been synthesised in the laboratory and, even if it had been, its industrial synthesis would, in any case, be too expensive. In view of the fact that the alkaloids of cinchona bark are not effective for certain therapeutic purposes, particularly for true causal prophylaxis, the prevention of relapses and the prevention of spread, the problem of finding a cheap and efficient quinine substitute is one of great importance.

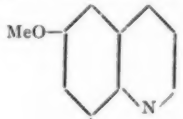
In 1891 Grimaux and Arnaud prepared from cupreine, a series of homologues of quinine, one of which, ethyl cupreine, was tested clinically and found to be somewhat more active than quinine. Tappeiner, as long ago as 1895, found that certain quinoline derivatives, notably 2-phenylquinoline, kill paramæcia *in vitro* in greater dilutions than quinine itself, but they failed to have any curative action on malaria. Before the structure of quinine had been elucidated by Hesse, Königs, and Rabe, attempts at the synthesis of compounds which might be similar in constitution to quinine led Knorr to the synthesis of antipyrine and Skraup in 1883 to that of the hydroquinoline derivative, thalline. Neither of these has any antimalarial action, though both are stronger antipyretics than quinine. In the year 1913, Kaufmann[2] synthesised β-piperidino-α-hydroxy-(6-ethoxyquinolyl-4)-ethane which was toxic to paramæcia and had a marked antipyretic action in human fevers. Schulemann and his co-workers in the laboratories of I. G. synthesised a series of quinoline and acridine derivatives with

[1] Buttle, Henry and Trevan, *Biochem. J.*, 1934, **28**, 426.

[2] *Ber.*, 1913, **46**, 1823.

a basic side-chain and these were tested by Roehl and Kikuth on canaries. The Bayer Company, in 1926, announced the preparation of a relatively simple compound, plasmoquine, which was stated to possess a specific action on the malarial parasite; this synthesis has proved to be the first step into a new field of chemotherapy.

Since the discovery of plasmoquine to which structure (I) has been assigned by the I. G. Farbenind. A.-G., several workers have synthesised compounds similar to plasmoquine in structure.



(I)

The derivatives of 8-aminoquinoline have special interest in connection with the subject of antimalarials; thus Baldwin[3] condensed 8-amino-6-ethoxyquinoline with γ-bromopropylphthalimide and obtained a product which, on hydrolysis, yielded the compound (II) similar in structure to plasmoquine.

(II)

The method developed by Baldwin has been extended by several workers,[4] and several products possessing powerful antimalarial properties[5] (against bird malaria) have been obtained. A few of them resemble plasmoquine and are nearly equal to it in potency. Fourneau and his collaborators[6] tested a series of such compounds on rice finch and found 8-diethylamino-propylamino-6-methoxy-quinoline to be equal, if not superior to plasmoquine and this has now been placed on the market under the name of plasmocid. Brahmachari and his co-workers[7] prepared some alkylaminoquinoline derivatives amongst which special mention may be made of 6-methoxy-8-amino*iso*propylaminoquinoline, structurally related to plasmoquine.

Whilst extending the above line of research for the preparation of new antimalarials, one should bear in mind that even small variations in the substituents (though of no interest from a purely chemical point of view) produce effects of marked biological significance. For instance, the 6-methoxyquinolines are more potent than the similarly substituted 6-ethoxyquinolines, and the length of the alkylaminoalkyl chain in position 8 of 8-amino-6-ethoxyquinoline has a considerable bearing on the activity. Magidson and Strukov[8] claim that the 6-hydroxy-derivatives are in some cases more active than the corresponding alkoxy-derivatives, the efficiency decreasing with the size of the alkoxy-group. In evaluating a drug, its therapeutic efficiency and toxicity are both taken into consideration, and in the study of antimalarials of the type of plasmoquine the aim should be to obtain products possessing lower toxicity combined with an equal or increased therapeutic efficiency.

Gunn and Marshall[9] reported that harmaline, although inferior to quinine, possesses curative value in acute malaria, whilst harmine, though valueless in acute cases, prevents recurrence of attacks in cases of relapsing malaria in which administration of quinine is without value. Robinson[10] has synthesised pyrroloquinolines having similarity in structure to harmine and harmaline. Pyrryl indoles, synthesised by Rây and his co-workers,[11] are likely to possess antimalarial properties, in view of their similarity to harmine. Preliminary trials have indicated that they have antipyretic properties. Glyoxalinquinolines, synthesised by Narang and Rây,[12] have been found to possess antimalarial properties and appear to be actively toxic to paramæcia in a dilution of 1 : 1000. Rây and his collaborators[13] have synthesised some derivatives

[3] *J. Chem. Soc.*, 1929, 2959.

[4] Kermack and Smith, *J. Chem. Soc.*, 1931, 3096; Baldwin and Robinson, *ibid.*, 1934, 1264; Meisel and Robinson, *ibid.*, 1934, 1267.

[5] Tate and Vincent, *Parasitology*, 1933, **25**, 411.

[6] Fourneau, Trefouel, Bovet and Benoit, *Ann. inst. Pasteur*, 1931, **46**, 514.

[7] Brahmachari and Das Gupta, *J. Indian Chem. Soc.*, 1932, **9**, 37, 207.

[8] *Arch. Pharm.*, 1933, **271**, 359.

[9] *Proc. Roy. Soc. Edin.* 1920, **15**, 145.

[10] *J. Chem. Soc.*, 1929, 2948.

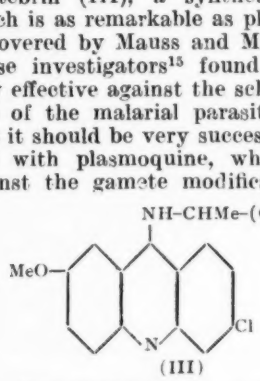
[11] Aggarwal, Qureshi and Rây, *J. Amer. Chem. Soc.*, 1932, **54**, 3988.

[12] *J. Chem. Soc.*, 1931, 976.

[13] Ahluwalia, Kochhar and Rây, *J. Indian Chem. Soc.*, 1932, **9**, 215.

of cotarnine. These have been found to have antipyretic properties but Chopra and his co-workers[14] have found, however, that anhydrocotarnineresorcinol hydrochloride has no antimalarial action.

Atebrin (III), a synthetic antimalarial which is as remarkable as plasmoquine, was discovered by Mauss and Mietzsch in 1930. These investigators[15] found atebrin to be very effective against the schizont modification of the malarial parasite and consider that it should be very successful in conjunction with plasmoquine, which is effective against the gamete modification.



(III)

According to the discoverers of atebrin, the most varied acridine derivatives of the above type and other ring systems containing similar basic aliphatic side-chains (*e.g.*, triphenylmethane, thiazine, xanthine; see *Klin. Woch.*, 1933, **12**, 1276) are active antimalarials. Walls[16] has recently synthesised a phenanthridine derivative containing the same basic side-chain as atebrin. The pharmacological examination shows that phenanthridine is notably less active than its otherwise closely analogous isomeride acridine and differs from the latter in its lack of dermatitic and sternutative action.

The recent use of salvarsan and stovarsol in benign tertian malaria, as well as that of mercurochrome (dibromohydroxy-mercurifluorescein) suggests that the study of organo-metallic compounds would constitute an useful line of enquiry.

The difficulty of forming an accurate estimate of the value of any particular antimalarial agent arises from the fact that the actual infection cannot be transmitted to laboratory animals. This difficulty was partially removed when Roehl devised his technique of testing such drugs in bird malaria, using canaries as test animals, but ultimately one is dependent on clinical trials for confirmation.

[14] Chopra, Mukherjee and Campbell, *Indian J. Med. Research*, 1933, **21**, 255.

[15] Mietzsch and Mauss, *Angew. Chem.*, 1934, **47**, 633.

[16] *J. Chem. Soc.*, 1935, 1405.

The Detection of Adulteration of Butterfat (Ghee).

(A Suggested Solution of an All-India Problem.)

By Prof. Dr. N. N. Godbole, M.A., B.Sc., Ph.D. (Berlin).
Benares Hindu University, Benares.

THE adulteration of butterfat (ghee) has been penalised by all the Provincial Governments of India and some of these have already taken very serious steps to punish the dealers in this important article of food, whenever the adulteration has been detected and proved in a law-court. Every province has got a special Chemical Analyser, whose business it is to examine and report on the samples of ghee (as also other food-stuffs) submitted to him for report. The act dealing with the prevention of food adulteration empowers the trying magistrates to decide the cases before them on the strength of the reports submitted by the special officers. In the interests of the vast public, it is but necessary to punish those who sell adulterated ghee (as also other adulterated food-stuffs). The responsibility which rests on the Chemical Analysers to the various Governments is therefore very great indeed. In the interests of justice and also in the interests of the public for whom justice is administered, it is of paramount importance that the investigation of the adulteration must be both scientific and correct.

In our investigation of this problem, we have come across certain points which need a very careful consideration. The main problem is, what are the correct physical and chemical constants of butter and butterfat from the scientific point of view? What are the limits of these? How is the purity or impurity of both butter and butterfat to be ascertained? Is there, in the first place, a correct knowledge of the composition of Indian butter or butterfat, from cows and buffaloes, either separately or mixed? Are the differ-

ent Provincial Analysts in India agreed on a unanimous standard of the limits of constants of pure butter and butterfat? Has sufficient work been done on the subject in India and have the chemists concerned met and discussed their experimental data obtained from Indian samples? All these questions must be answered and decided before any sample is pronounced as adulterated.

The results obtained in this Laboratory have already been published in the form of a booklet entitled *Butterfat* (by N. N. Godbole and Sadgopal) wherein certain new methods have been suggested. It is, of course, necessary that the methods proposed by us should be carefully examined by the Provincial Chemists before they are made generally applicable. It is, therefore, important to examine the various standards adopted by the Government Chemists in the different provinces of India. We are thankful to the various Chemists who supplied to us the information which has been put together in the following Table:

A brief summary of Standards adopted in various provinces of India for the purity of "Butterfat".

No.	Name of the Laboratory	Standards for mixed Butterfat		Remarks
		Refractive Index at 40° C. Butyro-reading	Reichert-Meissl Value	
1	Bengal, Government of	Not less than 40 and not more than 42·5	Not less than 28	Determination of Saponification value if necessary
2	Bihar and Orissa, Govt. of	40 to 42	Not less than 28	Phytosterol acetate test to be negative in all cases
3	Bombay Corporation	40 to 44·5	Not less than 24	
4	Calcutta Corporation	Not less than 40 and not more than 42·5	Not less than 28	Saponification value to be determined if necessary
5	Karachi Municipality	Not less than 40·5 and not more than 44·2	Not less than 24	Polenske value, Kirschner value and qualitative tests for hydrogenated oils are made when necessary
6	Lahore Municipality	Not less than 40 and not more than 41·6	24 to 32	Not more than 2·6 per cent. of free fatty acid allowed
7&8	Madras, Corporation of Madras, Government of	A general examination of the sample is made	Not less than 22, also should be above 27	Not more than 1 per cent moisture: Sterol acetate, Iso-oleic acid, etc. Isolation of Sterol acetate, estimation of Iso-oleic acid and other tests for a thorough examination
9	Mysore, Government of	——	——	No Standards are fixed as yet
10	Nagpur Municipality	From 40 to 46	From 19 to 36	——
11	New Delhi Municipality	——	——	No Standards are fixed as yet
12	Punjab, Government of	40 to 42	24 to 32	Baryta Value (Lallement's process to be negative. Free fatty acids to be not more than 2·8 per cent.)
13	Pusa, Agricultural Institute	Abbe's Scale 1·4524 to 1·4538	26 to 42	Saponification value and Iodine value (Hubl) are also determined if necessary
14	United Provinces— (*a*) Agra (*b*) Lucknow	Not less than 40 and not more than 51 at 25°C.	Not less than 28	Moisture to be not more than 1 per cent. and Saponification value to be determined if necessary

From the above Table, it is clear that the different provinces in India are not only not unanimous in their criteria of the purity of butterfat, but they differ widely even in the limits of the values they have laid down. A student of science or a specialist in oils and fats will find the differences in the standards of different provinces too wide to be justified. Indeed, looking to the values tabulated above, it is clear that a sample which will be pronounced as pure by one Provincial Analyst will be dismissed as positively adulterated by another Provincial Chemist. It is high-time, therefore, that a conference of all the chemists interested in the investigation of butter and butterfat be called as early as possible to discuss :

(1) the limits of the physical and chemical constants of pure butterfat, and
(2) to standardise the methods for the detection of the adulteration, both qualitative and quantitative.

Coming to the scientific aspect of the standards, just at present. the Reichert-Meissl Value and the Refractive Index (with the help of the Butyro-Refractometer) are the two main tests by which the purity of butterfat is ascertained in all the provinces. It is true that values like the Saponification Value, Iodine Value, Lallement's Baryta Value, Kirschner Value or the tests for iso-oleic acid and phytosterol acetate are used in certain laboratories as supplementary tests to confirm certain doubtful results and to enable one to draw a positive or a negative inference. In our opinion, the Reichert-Meissl Value which has a range for pure butterfat from 19 to 35 is too good to be used ; instead of that, we have proposed that the so-called A- and B-values (Bertram, Bos and Verhagen) which possess a very narrow range, should be used. These Values have been found by us to be extremely satisfactory in their results. From an analysis of nearly two hundred samples of cow's and buffalo's butterfats from all provinces of India, we have ascertained that the B-value, which has a very small range, gives most reliable results. We would very much like that this be further examined by Chemists to the different Provincial Governments in India, with samples available in different provinces.

The great difficulty in the analysis of butterfat has been that the various constants of pure butterfat possess a very wide range depending upon the nature of the animal, the season and the *type of food* that is given to it. It has been our experience that the A- and B-values and especially the B-values offer the least range in the limiting values. It can be mathematically shown that whereas even a 5% adulteration of butterfat appreciably affects the B-value, the adulteration of even 20%, under similar circumstances, cannot enable the chemists with the help of Reichert-Meissl Value, etc., to draw any positive inference in pronouncing a sample as adulterated. We are not aware of any other laboratory in India where much preliminary work has been done on the application of A- and B-values for detecting the adulteration of butterfat quantitatively. Messrs. Carl Zeiss of Jena, in their most recent German pamphlet pertaining to the use of Butyro-Refractometer, have been good enough to mention the work done by us at this University as a reference book on the subject. It will be out of the place to enter into a theoretical discussion of A- and B-values in this present paper. The theoretical books on the subject of Oils and Fats have already published the necessary information.

The Reichert-Meissl Value, as adopted in India, is of doubtful Value for another reason also. Most of the vegetable and animal oils and fats (excepting cocoanut, palm-kernel and butterfat) have a Reichert-Meissl Value which is almost negligible. But Dolphin oil — a kind of fish oil — has got a high Reichert-Meissl Value of 39 to 112 with the result that if this is hydrogenated and added to butterfat (which we understand is being done), it will make the application of Reichert-Meissl Value of very little importance in pronouncing a verdict on the question of adulteration.

The application of Refractive Index, as observed in the Butyro-Refractometer of Messrs. Carl Zeiss of Jena, is from our point of view of very great importance, not merely because of the reading it gives but because of the characteristic colour-fringes which have been observed by us (in spite of the compensating prism) as also by a few of the earliest workers and which have been discussed in detail in our pamphlet, entitled *Butterfat*. We have drawn the attention of the numerous workers in this line to these characteristic colour-fringes and so far we have received no complaints to the contrary. Experiments are in progress in this University to photograph these coloured lines to show whether the sample of butter-

fat under examination is adulterated or not. The range of degrees in the Butyro-Refractometer as given by the different Provincial Governments is not in agreement with the observation which we have made and have collected in our trials of a few hundreds of samples of pure butterfat. The range which we have observed for pure butterfat at 40°C. is from 40° – 44·8° on the scale of the Butyro-Refractometer.

In some of the Provincial Laboratories (*Vide* U. P. Government standards) the observations are taken at 25° C. We fail to understand how a reading could be taken at 25° C. or why it should be taken at all at 25° C. when we know that many samples of pure butterfat have a melting point very much above 25°C. As is well known, no reading could be correctly taken in the Butyro-Refractometer unless the sample is *in a melted condition*, during the process of examination. We have found in the case of many adulterated samples that the range of melting point exceeds 44·5° C. and the characteristic colour-fringes—bluish green or orange red, etc.—betray the adulteration of the sample. For a qualitative test, which does not take more than a few minutes, we are of opinion that the observation of the Refractive Index *along with the Coloured Lines* is of great help in pronouncing an opinion on the purity of a sample.

Regarding the other Values like the Saponification Value, Iodine Value, Kirschner Value, sterols, etc. although these are valuable in themselves, we do not think that *directly* they are of much help. At best, they will render only *supplementary help*. But we would emphasise that the A- and B-values, if carried out carefully, will enable a chemist to draw perhaps the most accurate inference. The other values because of their wide range cannot be of much help unless they are all *put together*.

It is imperative in the interests of national health that a very effective legislation should be enacted to stop the adulteration of butterfat, one of the most important foodstuffs of the vegetarian dietary. But at the same time it is equally desirable in the interests of science and justice that the standards adopted in various provinces should be thoroughly examined, corrected, and re-arranged in order to protect the legitimate interests of the dealers in this article.

Centenaries in February 1936.

Gray (Stephen), 1696-1736.

FIFTEENTH of this February marks the bicentenary of the death of Stephen Gray. The exact date of his birth is not known. It is generally believed that he was born in the year 1696. What little is known about him is to be gathered only from the internal evidence contained in his contributions to the *Philosophical Transactions* of the Royal Society. He appears to have lived originally in Canterbury. But most of his experiments in Electricity appear to have been made in Charter House, where he was residing as a pensioner and in the residences of his friends, Wheeler and Godfrey.

ELECTRICS AND NON-ELECTRICS.

His first paper on electricity is the one entitled *An Account of some new Electrical Experiments* and published in 1720 in Vol. 31 of the *Philosophical Transactions*. In this paper, he added the following ten substances to the list of "Electrics" known before his time:—"(1) Feathers. (2) Hair. (3) Silk. (4) Linen. (5) Woollen. (6) Paper. (7) Leather. (8) Wood. (9) Parchment. (10) Ox-guts in which leaf-gold is beaten."

CONDUCTION OF ELECTRICITY.

His greatest discovery was that of the conduction of electricity. This discovery was made in 1729 but was published in the *Philosophical Transactions* only in 1731. "He made several attempts to carry the electric virtue in a line horizontally" and failed. At last, on June 30, 1729, "Mr. Gray went to Otterden-place, to give Mr. Wheeler a specimen of his experiments.... as also of the method and materials made use of." Giving up the nail as the supporter of the line of pack-thread, he used, as suggested by Wheeler, a silk line to support it. With this "they succeeded far beyond expectation. The first experiment was made in the matted gallery, July 2, 1729, about 10 o'clock in the morning." The experiment was repeated with success with increasing lengths of pack-thread, until they succeeded in transmitting the effect, some days later, to a distance of 765 feet.

ELECTROSTATIC INDUCTION.

The fundamental phenomenon of induction, which forms the basis of electrical condensers was first described by Gray in the same paper of 1731. Mr. Gray made his first experiment in induction on August 5, 1729 and described it as "An experiment showing that the electric virtue may be carried several ways at the same time, by a line of communication, without touching the said line."

FIRST HUMAN BEING TO BE ELECTRIFIED.

The same paper of 1731 establishes the claim that Stephen Gray was the first man to electrify a human being. On "April 8, 1730, Mr. Gray made the following experiment on a boy between 8 and 9 years of age. His weight, with his clothes on, was 47 lb. 10 oz. He suspended him in a horizontal position, by 2 hair-lines, such as clothes are dried on: they were about 13 feet long, with loops at each end. There was driven into the beam of his chamber, a pair of hooks opposite to each other; and 2 feet from these another pair in the same manner. On these hooks the lines were suspended by their loops, so as to be in the manner of two swings, the lower parts hanging within about 2 feet from the floor of the room: then the boy was laid on these lines with his face downwards; one of the lines being put under his breast; the other under his thighs. Then the leaf-brass was laid on a stand, which was a round board of a foot diameter, with white paper pasted on it, supported on a pedestal a foot high, which Mr. Gray had frequently used in his experiments. The tube being rubbed, and held near his feet, without touching them, the leaf-brass was very vigorously attracted by the boy's face; so as to rise to the height of 8, and sometimes 10 inches."

This boy and another appear to have become a permanent part of Gray's apparatus and were in constant use. Mr. Gray would no doubt have had to display considerable daring at passing, for the first time, an electrical charge through a human being. Hence an individual of only a menial status was enlisted in the cause of science. His own footboy was chosen for that honour.

A POSTHUMOUS PAPER AND A DECEPTION.

Some Electrical Experiments intended to be communicated to the Royal Society, by Mr. Stephen Gray, F.R.S., and taken from his mouth by Cromwell Martimer, M.D., R.S.Sc., February 14, 1735–36, *being the day before he died* is the title of a paper which appears in Vol. 39 of the *Philosophical Transactions*. "He told the Doctor, he had thought of these experiments only a very short time before his falling sick; that he had not yet tried them with variety of bodies but that from what he had already seen of them which struck him with new surprise every time he repeated them, he hoped, if God would spare his life but a little longer, he should, from what these phenomena point out, bring his electrical experiments to the greatest perfection; and he did not doubt but in a short time to be able to astonish the world with a new sort of planetarium never before thought of, and that from these experiments might be established a certain theory for accounting for the motions of the grand planetarium of the universe."

Here, however, the dying man had been deceived. The familiar conjuring trick of the goblet and the ring was wrongly attributed by him to electrical forces.

Barring this posthumous paper, Mr. Gray had contributed nearly a dozen papers on electricity, each paper being usually in the form of a descriptive account of a number of experiments on electrical conduction and induction. Gray is said to have astonished his onlookers by drawing an electric spark from the surface of water kept in a drinking glass He used to maintain spheres and conical-shaped masses of sulphur in an electrified state for weeks and even months. Mr. Gray was essentially a pioneer and an earnest worker in experimental electricity. He richly deserves the appellation "Father of Electric Science" given him by Historians of Physics.

S. R. RANGANATHAN.

Adams (William Grylls), 1836-1915.

JUST a century after the death of the abovementioned "Father of Electrical Science," 16th February, 1836, saw the birth of W. G. Adams who advanced the sciences of Light, Electricity and Magnetism in no small measure before his death on 10th April, 1915. Adams was educated in a private school at Birkenhead and at St. John's College, Cambridge, and was subsequently elected a Fellow of that College.

In 1865 he succeeded Clark Maxwell as Professor of Natural Philosophy and Astronomy at the King's College, London and held that position till 1906. The Royal Society's *Catalogue of Scientific Papers* lists

25 papers of his in addition to a joint paper. The first paper *On the application of the screw to the floats of paddlewheels* was published in the *Philosophical Magazine* in 1865 and this constitutes his sole contribution to applied mechanics. His most famous contribution is to be found in Vol. 23 of the *Proceedings* of the Royal Society. It gives the substance of his Bakerian lecture on *The forms of equipotential curves and surfaces and lines of electric force.* He was one of the foundation members of the Physical Society of London.

The chief dates in his scientific career are the following :—

1872 Elected Fellow of the Royal Society.
1875 Delivered the Bakerian lecture.
1879 President of the Physical Society.
1880 President of the A Section of the British Association.
1883 Delivered Cantor lectures on electric lighting.
1884 President of the Institution of Electrical Engineers.

S. R. RANGANATHAN.

Obituary.

Mr. V. Ramaswami Aiyar, M.A. (1871-1936).

IT is with very deep regret that we learnt that the founder of the Indian Mathematical Society (started as the Indian Mathematical Club in 1906), Mr. V. Ramaswami Aiyar, M.A., retired Deputy Collector, suddenly passed away at Chittoor on the 22nd ultimo.

Mr. V. Ramaswami Aiyar was born in 1871 in Coimbatore district. After a brilliant educational career he served for a short time in the Central College, Bangalore and the Maharajah's College, Mysore, and (rather unfortunately for the development of mathematical research in India) he then entered the Madras Civil Service. His interest in mathematics continued unabated till his death all through his career as a revenue and judicial officer. It is even rumoured that this contributed adversely to his advancement in service. He was an outstanding example of a very enthusiastic lover of mathematical research. One of his great aims was to promote the cause of mathematical research in India. It can easily be said that he has achieved it remarkably well, considering the fact that India entered the field of mathematical research after a lapse of nearly ten centuries.

One memorable episode of his life was the discovery of Ramanujan, one of the greatest geniuses of mathematics that the world has ever produced.

The place of Mr. V. Ramaswami Aiyar in the development of mathematical research in India cannot be determined solely by the work that he produced. If he were born in an advanced western country with ample opportunities for learning under great workers with every sort of facility, he would no doubt have contributed substantial works. At least if he were a professor of mathematics in any of our universities, his great imagination, which stands forth prominently in his contributions to the so-called "Modern Geometry of the Triangle", would perhaps have been used in modern projectile geometry producing valuable results. His were days when very few people in India realised that there was mathematical research beyond the problems in Journals such as the *Educational Times.*

Perhaps his was the only example of a research worker and enthusiast in mathematics in India outside the ranks of our universities, whose interests continued unabated all through his life. We offer our sincere condolences to his bereaved family.

Letters to the Editor.

CONTENTS.

Note on the Linkage of MgO.

RECENTLY it has been shown[1] that molecules of the BeO type do not possess a double bond in the vapour state, but are singly linked only, according to the formula –Be–O–. By combination of unexcited oxygen with the excited term $sp\,^3P$ the ground state $^1\Sigma$ of the molecule is formed. Therefore its electronic configuration indicates, that only the *p*-electron of Be has joined electrons of O in the same quantum group, or, in the interpretation of the molecular orbital method as a pair bond theory of valency, only a single bond is produced. This interpretation of the analysis of the band spectrum has been confirmed in various ways.[2] Hund[3] has recently shown by wave-mechanical considerations, that the crystals of non-volatile insulators possess a lattice formed by true localised covalent bonds between the units of the crystal. To this class belong also BeO, ZnO, ZnS, CdS and HgS on account of their extremely high melt ng points and it has been pointed out[4] that this agrees indeed very well with the fact, that such molecules possess free valencies in the vapour state, being linked by a single bond only. Electronic terms with more than two free valencies lie immediately above the ground state and may easily become the lowest ones in the crystal, on account of the greater number of valencies being capable of existence and the larger amount of energy being liberated in their formation.[2] Indeed, these molecules crystallise in the zincblende and wurtzit types, which, together with that of diamond, have been taken as typical of true covalent linkage in the crystalline state for a long time.[5]

Other similar molecules, *e.g.*, MgO, CaO, etc., crystallise in the NaCl type, but they possess the same extremely high melting point and at least MgO, probably also CaO and SrO, possess the same terms and configurations in the vapour state as BeO. It would be very natural to apply the same considerations to them and to assume that such crystals are likewise formed by true chemical bonds between the lattice points. But the NaCl structure has always been considered to be the prototype of ionic linkage in the solid state. Since, however, X-ray spectroscopy obtains the geometrical arrangement of the atoms or ions in the first instance and the physical nature of the forces is inferred only by further assumptions, however plausible, it appears not to be impossible

that these crystals MgO etc. belong to the covalent non-ionic type for similar reasons as given by Hund for BeO or ZnO, in spite of the geometrical arrangement being of the NaCl type. The purpose of this note is to draw attention to such an interpretation. Even if such an assumption possesses only a remote probability and is put forward here with all reservation only, it appears interesting enough, to discuss it.

The infra-red absorption spectrum of MgO and CaO crystals has been measured some time ago by Tolksdorf[6] who finds the fundamental frequencies $\nu = 14{\cdot}2$ and $22{\cdot}05\mu$ respectively and several overtones, among them the frequencies $2\nu = 7{\cdot}65$ and $9{\cdot}75\mu$ respectively. The existence of the octave was unexpected, because, according to theoretical calculations,[7] this frequency is forbidden in the NaCl type. The field surrounding each ion in this structure, (if indeed made up of Mg^{2+} and O^{2-} ions) is completely symmetrical, the restoring force has always the same value independent of the direction and hence the law of force contains the odd powers of the displacement only. Therefore, these crystals should exhibit the odd overtones only. Indeed, Schæfer and Matossi,[8] while discussing the experimental result, surmise that "unsymmetries are produced by the electronic configuration in such a way, that two atoms each are connected in a stronger bound molecule" and assume that the regular symmetry obtains on the average. But, naturally assuming that the crystal is built up of ions, they do not pursue this idea, because similar results should then occur also in the true ionic crystals of the same type, like NaCl, where they are certainly not present.

From the point of view of band spectroscopy, the molecule NaCl is a genuine electrovalent molecule in the vapour state whereas MgO possesses a covalent bond. Whether it persists in the crystalline state, cannot be known *a priori*, but it is interesting to follow the later development of this question. On account of certain experiments of Czerny and his collaborators, Born and Blackman[9] introduced the anharmonic factor in addition to the harmonic constant and found that secondary maximas should appear in the infra-red spectrum. Barnes, Brattain and Seitz[10] come to similar conclusions by wavemechanical calculations. In any case, however, these maxima are weak and the introduction of the anharmonic constant cannot account for the appearance of two active frequencies in the gross structure. Experimentally such additional subsidiary maxima have been found not only in molecules like NaCl but also in MgO, but this fine structure has no immediate bearing on our problem. From our point of view we are only interested in the occurrence of the *main* maxima and it does not matter, whether they are accompanied by subsidiary maxima on account of the anharmonic factor, or not. Strong[11] however, investigating the far infra-red, reports a further region of selective absorption in the neighbourhood of 23μ. This is by no means double the value of $14{\cdot}2\mu$ of Tolksdorf or the double-headed maximum at 14·8 and 15·3 of Barnes, Brattain and Seitz. But considering the *gross structure* only, the experimental results of infra-red spectroscopy are not yet clear and it is not possible, definitely to correlate the measured main maxima to a fundamental vibration and the various overtones. They appear, however, much too complicated for a symmetrical cubic lattice, and they resemble much more that of the hexagonal BeO crystal with its 2 active vibrations and their overtones in the gross structure, indicating a favoured direction in the lattice. It seems therefore not impossible, that the MgO crystal is in reality a giant molecule with covalent bonds. According to the possible electronic configurations the 6 bonds, exhibited by a slightly excited term of the MgO molecule, would possess different strength, probably more than can be accounted for by the introduction of the anharmonic constant in the second approximation. This would explain the complicated structure of the infra-red spectrum, the existence of several main maxima and also, why the vibrations lie at about 23μ and the new "octave" at about 15μ.

In the present unsatisfactory state of knowledge as to the experimental facts, this is of course a mere assumption, and we only want to draw attention to such a possibility, because it would agree with the wavemechanical considerations on the structures of non-volatile insulators and the conclusions of band spectroscopy. It is a matter of personal opinion, whether these arguments are already sufficient, to modify the viewpoint, based on X-ray spectroscopy, that the NaCl structure is a rigorously valid criterion of electrovalent linkage. In this connection, however, attention should be

drawn to the fact, that the same geometrical arrangement may be exhibited in cases, in which the nature of the bonding forces is certainly quite different. As typical examples we may consider again the double salts (KF, MgF_2) or (CsCl, $CdCl_2$) which crystallise with the same structure as KIO_3. There exists doubtless a MgF_3 or $CdCl_3$ group in the crystal in the geometrical sense, similar to the IO_3 group, but only the latter one is a chemical individual, preserving its entity, for instance in solution. It exists on account of the heptavalency of iodine, which possesses seven outside electrons, whereas a trivalency of Mg or Cd are out of question; the existence of the MgF_3 group is due to the formation of a mixed crystal (solid solution) which mostly decompose at lower temperatures. Thus the linkage inside the MgF_3 and IO_3 group are entirely different. Similarly SiO_2 (in β-tridymite) possesses the same structure as ice. But H_2O is a saturated molecule and forms therefore a volatile molecular lattice, in which the individual water molecules are connected with each other by Van der Waal's forces only, whereas SiO_2 is a typical non-volatile insulator, each Si atom is linked to four O atoms, each O atom to two Si atoms, and all these bonds are true covalent linkages. Such examples make it easier to understand, that the crystal lattice as such is not necessarily a rigorously valid criterion as to the nature of the physical forces. The crystal is always formed with that structure, which, under the particular conditions, exhibits the minimum of energy and therefore the same few arrangements of high geometrical symmetry obtain always, independent on the type of linkage. Among the necessary conditions for a particular structure those of a geometrical nature, as for instance the ratio of the atomic radii predominate again over those of a more physical nature, *e.g.*, the polarisibility of the ions. It appears therefore quite conceivable, that the oxides of Mg and Ca belong in reality to the type of giant molecules, *i.e.*, non-volatile insulators, with true covalent bonds linking the units of the lattice, even at a sacrifice of the conception of the NaCl structure as a criterion of ionic linkage.

H. LESSHEIM.
R. SAMUEL.

[1] H. Lessheim and R. Samuel, *Z. Phys.*, 1933, **84**, 637; 1934, **88**, 276.

[2] H. Lessheim and R. Samuel, *Ind. Acad. Sci.* (Bangalore), 1935, **1**, 623; *Phil. Mag.* (in press); P. C. Mahanti, *Ind. Journ. Phys.*, 1935, **9**, 517.

[3] F. Hund, *Z. Phys.*, 1932, **74**, 1; Report "Intern. Conference, 1934", *Physic. Soc. London*, 1935, Vol. 2, p. 36.

[4] R. Samuel, Report "Absorption Spectra and Chemical Linkage", *Ind. Acad. Sci.* (Bangalore), 1935; H. Lessheim and R. Samuel, *loc. cit.*

[5] H. G. Grimm and A. Sommerfeld, *Z. Phys.*, 1926, **36**, 36.

[6] S. Tolksdorf, *Z. Phys. Chem.*, 1928, **132**, 161.

[7] C. J. Brester, *Diss. Utrecht.* 1923; *Z. Phys.*, 1924, **24**, 334.

[8] Cl. Schæfer and F. Matossi, *Das ultrarote Spectrum*. Berlin, 1930, p. 309 ff.

[9] M. Born and M. Blackman, *Z. Phys.*, 1933, **82**, 551; M. Blackman, *Z. Phys.*, 1933, **86**, 421.

[10] R. B. Barnes, R. R. Brattain and F. Seitz, *Phys. Rev.*, 1935, **48**, 582 and earlier.

[11] Strong, *Phys. Rev*, 1931, **37**, 1565.

The Iso-electric Point of Vitamin B_1.

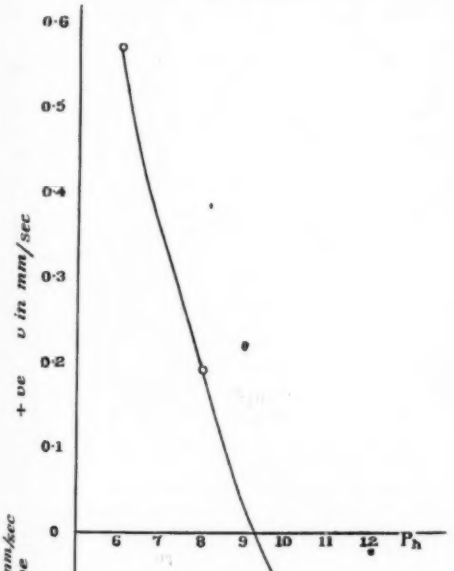
STUDY of the behaviour of vitamin B_1 in an electric field at different levels of hydrogen-ion concentration assists in elucidating its chemical nature. Previous attempts have been made to determine the iso-electric point of the vitamin (Birch and Guha,[1] 1931; Sankaran and De,[2] 1934; Ghosh and Guha,[3] 1935). Sankaran and De reported that the iso-electric point is in the acid range (pH 3·0) while Guha and his collaborators found it to be in the alkaline range at pH 8·5. These discordant results may be ascribed to the use of impure vitamin B_1 preparations; further, the values obtained were not confirmed by satisfactory biological tests.

I have recently reinvestigated the problem by the method of electrophoresis, using crystalline vitamin B_1 prepared according to the method of Kinnersley and Peters,[4] (1933). Electrical migration experiments, with suitable voltage and current strength, were carried out at 6 levels of pH, with solutions containing 300 ν of vitamin B_1 and the contents of the pole chambers tested chemically for vitamin B_1 (Peters *et al*, 1934).[5] The results were as follows:

pH	Quantity of B_1 migrating towards		Nature of charge of B_1
	Positive Pole	Negative Pole	
5·8	0·0 ν	75 ν	+ ve
8·0	0·0 ,,	120 ,,	+ ve
9·0	0·0 ,,	31·9 ,,	+ ve
10·0	44·0 ,,	21·0 ,,	± ve
11·0	30·0 ,,	0·0 ,,	− ve
12·9	114·0 ,,	0·0 ,,	− ve

The above values are calculated for the same strength of current. The contents of the various chambers were tested biologically by feeding them to polyneuritic pigeons, and the biological test gave results in substantial agreement with those obtained by chemical assay.

The same problem was further studied by the method of micro-cataphoresis, using the Brown and Broom cell as modified by Millwood.[6] The migration velocity of Kieselguhr particles was determined at various levels of pH — (*a*) without vitamin B_1, (*b*) with the vitamin adsorbed on the particles. The difference in velocity so observed was calculated with due attention to the sign of the charge. The results are shown graphically in the following figure, in which the



ordinates represent the change in velocity produced by the vitamin, and the abscissæ various values of pH. The velocities are in mm./sec. with a current strength of 1 milliamp. and voltage 220 acting between poles 16 cms. apart.

The results of the micro-cataphoresis experiments indicate that the iso-electric point lies between pH 9 and 10, nearer 9 than 10. From the graph its location appears to be at about pH 9·2.

Full details of these experiments will be published in the *Indian Journal of Medical Research*.

G. NARASIMHAMURTHY.
Nutrition Research Laboratories,
Coonoor.
February 5, 1936.

[1] Birch, T. W., and Guha, B. C., *Biochem. J.*, 1931, **25**, 4. 1391.
[2] Sankaran, G., and Dr. N. K., *Ind. Jour. Med. Res.*, Oct. 1934, **22**, No. 2, 233.
[3] Ghosh, A. C., and Guha, B. C., *Curr. Sci.*, May 1935, **3**, 555.
[4] Kinnersley, H. W., *et al.*, *Biochem. J.*, 1933, **27**, No. 1, 225.
[5] Kinnersley, H. W., *et al.*, *Biochem. J.*, 1934, **28**, 667.
[6] Brown, H. C., and Broom, J. C., '*System of Bacteriol*', 1931, **9**, 278.

Identity of Noroxylin with Baicalein.

IN continuation of our previous letter on the constitution of Oroxylin[1] we have now confirmed our conclusion that noroxylin is baicalein by means of a mixed melting point determination with an authentic sample of baicalein kindly supplied by Professor Keita Shibata. There would seem to be no doubt, therefore, that oroxylin is the 6-methyl ether of baicalein.

R. C. SHAH.
C. R. MEHTA.
T. S. WHEELER.
Royal Institute of Science,
Bombay,
February 12, 1936.

[1] *Curr. Sci.*, 1935, **4**, 406.

Pollen Grains in the Stylar Canal and in the Ovary of an Angiosperm.

IN a letter to *Nature* last August Mr. B. M. Johri[1] of Agra announced the discovery of pollen grains lying inside the stylar canal, and in one case even inside the ovary, of an angiosperm, *Butomopsis lanceolata* Kunth. An outline sketch of a longitudinal section of the ovary shows that *the stylar canal opens to the exterior through the stigma*. There is a row of five pollen grains arrested in the upper part of the canal, the diameter of which, according to the sketch published, is about 1½ to 2 times as large as that of the spores. The pollen found in the ovary was not figured. As the full description is not yet available one cannot say whether these pollen grains belonged to the species in whose ovary they were found.

Mr. Johri states that "in one case a pollen grain had germinated and sent out a small pollen tube", but he does not say whether this pollen grain was in the stylar canal or in the ovary. The fact that it had put out a pollen tube, although interesting, is no proof that it was not a "foreign" spore;[6] Mr. Johri will no doubt clear this point in the full paper. "Usually the pollen grains germinate on the stigma."

The development of the female gametophyte has interesting features of its own, but to the present writer the pollination phenomena briefly described by Mr. Johri seem to surpass them in importance. For, whether the pollen grains found in the ovary and stylar canal belong to *Butomopsis* or not, their occurrence in these positions, even though occasional, is a distinctly gymnospermous feature. It seems impossible to explain the entry of these spores, even into the upper part of the canal, except on the assumption that they were drawn in by some sort of suction mechanism like that of the "stigmatic drop" of gymnosperms, the stylar canal functioning like a micropyle.

One is at once reminded of Professor T. M. Harris's recent discovery, (which obviously deserves wider notice) of pollen grains inside the supposed "angiospermic" fruit of a new species of *Caytonia*, *C. Thomasi* T. M. Harris.[1,2] Professor Harris (1933) has figured preparations, some of which I have had the privilege of examining in his laboratory, and which leave no room for doubt that at least at pollination time the fruits were not closed. The ovules were open to access by pollen grains, as in the gymnosperms. Harris writes that "the considerable majority of well-preserved seeds.....possess pollen grains..... in their micropyle", while "practically no pollen grains (apart from those in micropyles) occur in the interior of the fruit". From the appearance of cuticular preparations of the stigma and fruit, both in *C. Sewardi* and *C. Thomasi*, it is inferred that the pollen grains gained access to the micropyles through definitely organised canals, at the tips of which the spores were probably caught in "stigmatic drops" secreted by the ovules.

One might imagine some such result if the incurved ovuliferous organ of a *Stachyotaxus* or of a *Palissya*-like gymnosperm were to become completely doubled upon itself, the opposing inner surfaces leaving only narrow chinks between them for the ingress of pollen. However that may be, Harris's discovery on the one hand, and Johri's on the other, are enough to set one thinking, to say the least. Either we must relax our definition of an angiosperm, or we must be prepared to agree that *Caytonia*, at least, is not yet quite an angiosperm! And if you thus make a breach in the supposed angiospermy[7,8] of the Caytoniales through the perforated ovary of their type genus, who knows what is in store for *Gristhorpia* and the rest? Indeed, Harris's 1933 work (p. 112) tends to make it possible that the difference between *Caytonia* and *Gristhorpia* may not be of generic rank.

Now, if the mode of pollination in *Caytonia* is to bring that genus within the gymnosperm fold, where Prof. Kräusel had already placed the whole group,[5] what of *Butomopsis*, an undoubted angiosperm, and a monocotyledon at that? Shall we say that it has retained the open stylar canal, postulated by Professor Harris (p. 108) for the primitive angiosperms? This seems to be the only natural and reasonable conclusion, although it is opposed to Mr. A. C. Joshi's attractive theory (1934) that the stylar canal of angiosperms owes its origin to the disintegration of a vascular tract in the carpel.[4]

The whole question is very intriguing, and we obviously need more facts, covering a wider field; but Mr. Johri deserves thanks for bringing to notice what can only be regarded as a relic of gymnospermy in a confirmed and unquestionable angiosperm. It is not unlikely that many other instances of the kind have passed unnoticed, because modern workers on angiosperm life-histories do not so often investigate the styles and stigmas as it seems they should, and no doubt will do in future, with the recent revival in carpel studies.

Dr. Hamshaw Thomas's work on the Caytoniales will always remain a classic of palæobotanical investigation, in which the possibilities of cuticular technique were demonstrated in a brilliant manner. Although one need not stand committed to all his theoretical conclusions he has certainly shown an *approach* to angiospermy,[9] and has set others on the quest.*

The University, Lucknow. B. SAHNI.
January 18, 1936.

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* Since my note on pollen grains was communicated Mr. Johri of Agra has kindly shown me

some of his selections. I am satisfied that the pollen grains figured by him in the stylar canal belong to the *Butomopsis*: they are identical in character with the pollen grains found in the anthers of this plant. I have not seen the sections showing pollen grains inside the ovary, but there is no reason to doubt the accuracy of his observation. These observations should be worthy of a detailed record even if the pollen grains were "foreign". Mr. Johri's full paper may be awaited with interest.

[1] Harris, T. M., "The fossil flora of Scoresby Sound, East Greenland," *Medd. om Grönland.*, **1932, 85**, 1-133.

[2] Harris, T. M., "A new member of the Caytoniales," *New Phyt.*, **1933, 33**, 97-114.

[3] Johri, B. M., "Life-history of *Butomopsis lanceolata* Kunth," *Nature*, **1935, 136**, 338.

[4] Joshi, A.C., "Morphology of the stylar canal in angiosperms," *Ann. of Bot.*, **1934, 48**, 967-974.

[5] Krausel, R., in Engler's *Nat. Pflanzenfam.* 2nd ed., **1926, 13.**

[6] Sahni, B., "Foreign pollen in the ovules of *Ginkgo* and of fossil plants," *New Phyt.*, **1915, 14**, 149-151.

[7] Thomas, H. Hamshaw, "The Caytoniales, a new group of Angiospermous plants from the Jurassic rocks of Yorkshire," *Phil. Trans. Roy. Soc.* London, Ser. B., **1925, 213.**

[8] Thomas, H. Hamshaw, "The early evolution of the angiosperms," *Ann. of Bot.*, **1931, 45**, 652, 654.

[9] Thomas, H. Hamshaw, "The nature and origin of the stigma," *New Phyt.*, **1934, 33**, 173-198.

With reference to the above note of Prof. B. Sahni, a copy of which was kindly shown to me about a week after it had been sent to the press, I think it necessary to make the following remarks. The necessary figures and some other interesting details will be found in my full paper which will soon appear elsewhere.

1. In the stylar canal of one carpel there was a row of six pollen grains of which five could be seen in a single section. It is this that was figured in the note published by me in *Nature*. The pollen grains are approximately 24 microns in diameter and the stylar canal is 1½ to 2 times as wide.

2. In a dozen other cases (from three different flowers) pollen grains were found *inside the ovary*. One of these was located on the surface of an ovule (which was unfortunately cut obliquely) and had actually germinated, although the pollen tube was very short.

The writer was himself greatly surprised when he saw these pollen grains in such unexpected quarters and a careful examination of their size and nuclear contents left no doubt whatever that they *belonged to the same species*.

Before entering into a detailed discussion of the theoretical bearings of this discovery, the writer wished to be sure whether a similar thing had been observed before in any other plant. An enquiry from Prof. K. Schnarf of Vienna brought forth the reply last month, that the phenomenon was absolutely unique and had never been noticed by him in the existing literature on Angiosperms.

As Prof. Sahni has pointed out, the occurrence of pollen grains inside the ovary of an undoubted angiosperm like *Butomopsis*, sets one thinking about the difference between a Gymnosperm and an Angiosperm. *Caytonia Thomasi* provides material for comparison and speculation; and so does *Gnetum*, if we agree to designate the inner envelope as a stylar canal and not as an integument.

B. M. JOHRI.

Botany Department,
Agra College, Agra,
February 1, 1936.

Chromosome Numbers in *Phœnix farinifera*, Roxb.

TWENTY-ONE species of *Phœnix* have been enumerated in the *Index Kewensis*; of these, five species are natives of South India. The chromosome numbers of the various species are not available except for the cultivated date palm—*Phœnix dactylifera*, Linn. Nemec (1910) gives the $2n$ number as 28.

The author of the present note has, from several counts made in the metaphase plates of pollen mother-cells, determined the haploid (n) number of chromosomes in *Phœnix farinifera*, Roxb. (common on the east coast of the Peninsula) as 18.

G. V. NARAYANA.

Oil Seeds Section,
Agricultural Research Institute,
Coimbatore,
January 6, 1936.

Ram Sarcophagus from Cuddappah.

WITH reference to Mr. M. D. Raghavan's article on "A Ram Sarcophagus from Cuddappah" appearing in 1935, November issue of *Current Science*, the following observations may be of interest.

After seeing the object in the Madras Museum and after examining its detachable head carefully, I find myself unable to

agree to the author's statement that the "Ram's head is clearly modelled". Except for what the author calls "the curling horns", I fail to find anything to warrant the conclusion that the object is a clear model of a ram's head. On the other hand, the slightly curving and tapering facial portion and the omission of the ears (especially when the artist has taken pains to mark the position of the comparatively smaller eyes and the nasal holes) seem to suggest that the maker intended this removable head portion of the sarcophagus to represent a hovering bird (perhaps a Vulture) and not the head of a ram. If it represents a hovering bird, then the "curling horns" may be taken to represent a pair of sturdy wings. Again this part of the sarcophagus is so small and suits so ill the rest of it from the point of view of proportion, that it raises in my mind the doubt, whether the person who made the object ever meant this sarcophagus to represent a ram. The presence of the six legs adds colour to this doubt.

Composite objects are not uncommon in pre-historic archæology. It seems to me to be more reasonable to call this sarcophagus a composite object than to christen it a "ram sarcophagus". It may be a fantastic representation of some mythological figure associated with death that loomed large in the minds of those pastoral people. One must remember that the big, the unnatural, the grotesque and the unknown appealed to the primitive mind more than anything else and the primitive man made attempts whenever he had opportunities to represent his imaginary pictures of these in his handicrafts.

Further on in the article the author makes mention that this sarcophagus is the second "funerary vessel in animal form known from South India". This is incorrect. The Superintendent of Archæology, Cochin State, in his annual report of the Archæological Department of the Cochin State for the year 1109 M. E. (1933-34 A.D.) mentions that a sarcophagus which has "the appearance of a cow in a lying posture" was discovered at Kattakampal in the year 1933-1934. This report was published a few months before or very shortly after this supposed "Ram Sarcophagus" was unearthed.

K. GOVINDA MENON.

Madras,
February 5, 1936.

The Mineral Bababudanite—An Explanation.

IN my reply to Mr. M. B. Ramachandra Rao's letter entitled "The Kaldurga Conglomerates and the Iron Ore Series of the Bababudans, Kadur District, Mysore," published in this *Journal* (Dec. 1935), I am afraid I have not made myself quite clear in my remarks regarding the origin of the mineral bababudanite when I said "my colleague, M. R. Srinivasa Rao, and I were the first to point out that the mineral was developed as a result of thermal metamorphism." The intention at the time of writing this was not what this statement would literally imply, for I was aware that Jayaram had suggested the secondary nature of bababudanite and I have myself referred to it in one of my papers.[1] What was intended to be claimed was, that the exact nature of the rocks involved in the process of metamorphism giving rise to bababudanite, was elucidated for the first time in the course of my work.

CHARLES S. PICHAMUTHU.

Central College,
Bangalore,
February 5, 1936.

[1] C. S. Pichamuthu, *Curr. Sci.*, 1935, **3**, 608.

Mathematics and the Sciences.

THE review of *Descriptive Mathematics* on page 556 of the January number of *Current Science* demands comment. The book reviewed is *not* a companion volume to *Graphs and Statistics*, though a contrast to it. Nor is it a book for "statisticians whose background of mathematics is negligible"; if it were so, why the title *Descriptive Mathematics*? Your reviewer seems to have got nowhere near the standpoint of the book. One difficulty seems to be that the unique situation we enjoy here in Bombay is not appreciated—it is possible for us to act in making striking departures from the ordinary courses in elementary College mathematics without taking the whole body of teachers with us immediately. *Descriptive Mathematics* is an endeavour to define such a departure, not to popularise it; but the standards your reviewer appears to have applied in valuing the book are quite conventional. He merely thinks of students as they are, and not as they might be were they successfully led through such a course as is proposed. He seems, so far as his ideas are clear, to differ in no essential respect from

those who were expected, according to the preface of the book, to look askance at certain methods used and to say that the thing proposed could not be done.

But the plain fact is that something needs to be done. Not a few specialists in economics and in the biological sciences feel the necessity of stopping to prepare courses in elementary statistics, etc., for the benefit of their colleagues in order to deal more effectively with the problems of their own researches. These courses, applicable in subjects ranging from textiles to physiology, have a very great deal in common. Again, inept use, or the avoidance, of elementary mathematics in the physical sciences could be abundantly illustrated. These are, I think, but indications of a misdirection in the general outlook on mathematics; and certainly the ordinary courses in mathematics meet such needs not even in an indirect way. We cannot long continue to ignore this defect in our educational practice, and a first task must be to discuss the lines along which we should move away from the present mathematical courses. In *Descriptive Mathematics* is a definite proposal to this end for first year students only, not for the second (Intermediate) year; but your reviewer can see nothing new in it, and merely judges it from a conservative standpoint. (To take one simple instance: I should like to know if there be anywhere else an examination of the principles of slide rules comparable with that on page 97.) When we have achieved a reasonable measure of agreement as to what aspects of elementary mathematics should be taught, there will be no lack of endeavours to write books suited to examination purposes. But that is not the criterion to apply at this stage.

JOHN MACLEAN.

Wilson College, Bombay,
February 2, 1936.

I HAVE perused Prof. Maclean's comment. Prof. Maclean is a distinguished educationist of Bombay and we have high respect for his services to the cause of education. But so far as his present book is concerned, I cannot help expressing my frank and honest opinion without any reservations. I shall not worry myself about this charge of conservatism on my part, but I shall dwell with emphasis on one point only:

The average man has a general dislike for or difficulty to follow the theory of mathematics. It must be the endeavour of every mathematics teacher of the elementary stage to present the subject with as much simplicity as possible, confining in the earlier stages only to the *intrinsic beauty* of the subject, omitting all details and complications to a later stage. To most people, even to many mathematicians themselves, numerical work and heavy calculations are disgusting. From the boy at school who works on vulgar fractions and decimals, to the average public man, heavy arithmetic is never taken as matter of love. This is a general human weakness, and not all the slide rules in the world can remedy this to any remarkable extent. If then heavy numerical work is taken as a necessary adjunct to the elementary principles and methods of mathematics, and the result of this fusion is called *Descriptive Mathematics*, it is my frank opinion that most people would bid good-bye to this kind of mathematics. Experimental Scientists, and research workers in Social Sciences require and will automatically cultivate the required speed and accuracy in numerical work, when they settle down at their work, but to inflict this kind of work on a poor First Year Intermediate student is horrible!

I remember our learned Editor of the *Current Science*, in the course of a speech somewhere saying to the following effect: To the Physicist, everything in this world will appear as Physics and Chemistry, to the Biologist, everything will appear as Biology, etc. Likewise, shall I say that a Statistician cannot *describe* simple elementary principles of mathematics without asking his boys

(1) to use the slide rule and verify

$$\frac{2}{\pi} = \frac{\sqrt{2}}{2}\,\frac{\sqrt{(2+\sqrt{2})}}{2}\,\frac{\sqrt{\{2+\sqrt{(2+\sqrt{2})}\}}}{2}$$

(2) to draw the curve $y = 1320x^{-0.9234}$

(3) to solve $10000\ (\sin 3x + 2\tfrac{1}{2}\cos 2x) = x^2 - 300x + 9000$?

These are a few specimens from the book.

I have no personal dislike for statistics and I have some little pretensions for the subject myself; I can also boast myself to be a moderately good computer. But there is a difference between having a knack for this work or cultivating it as one's needs arise, and gulping this down on a poor Intermediate student.

One can see in Prof. Maclean's book in many places the hand of an experienced and able exponent of the subject, but in my

opinion this is marred by an over-filling of numerical work.

Here are two specimens (not typical, though) of *Descriptive Mathematics* :—

(*a*) "On March 21 the number of seconds taken by the sun to cross the horizon in latitude l is $32/15 \sec l$; find this for $l = 19°$ and $l = 60°$" (p. 58).

Is this illustration going to create a new interest in the student for the secant function, or is it going to be the nucleus of his future astronomical studies, or does it just show off the pedantry of the author ?

(*b*) "Note sets of words like "due, duty, dutifully" which are useful in teaching time in music. The periods of the syllables of these words are as 4 : 2 : 1. Consider the possibility that rhythm in speech and in prose may be partly and automatically determined by the essential periods and intensities of syllables. (In poetic rhythm there is of course deliberate selection of combinations of syllables)". (p. 60.)

This example follows problems like sketching the curves corresponding to $\cos^2 x$, $\cos^3 x$, etc. I have no music in me, but frankly, this piece of mathematics is beyond me.

C. N. S.

Research Notes.

On Ternions in Geometry.

HANS BECK (*Math. Zeit.*, **40**, 4, pp. 509-520) has investigated the occurrence of the linear transformation group of the system of non-commutative ternions, under various forms in several places in geometry. Let A, B, C, D be four ternions, then the linear transformation is $X' = (Cx+D)^{-1}(Ax+B)$. Now it is known that apart from the non-commutative system of the ternions, there exist two other commutative systems of ternions. In the latter cases, the linear transformation-group reduces itself to one of nine parameters. This is not of so much importance as the group in the non-commutative case, of eleven proper parameters. Beck has shown that this group occurs in the following places in geometry: (1) A special collineation group of a linear-complex; (2) A cremona group in affine space; (3) The group of Laguerre transformations of directed planes; and (4) The group of rotations (in the same sense) in the four dimensional Euclidean space, etc.

A ternion of the system is represented as $A = A_0E_0 + A_1E_1 + A_2E_2$ and the multiplication table is

$$\begin{vmatrix} E_0 & E_1 & E_2 \\ E_1 & E_0 & E_2 \\ E_2 & -E_2 & O_0 \end{vmatrix}$$

E_0 can be taken to be the scalar unit. The norm $N(A) = A_0^2 - A_1^2$ (Hence reducible). If $\xi_0, \xi_1, \xi_2, \xi_3$ are the co-ordinates of a point in a projective R_3 and the Plucker's co-ordinates of a line are $P_{ik} = \xi_i \eta_k - \eta_i \xi_k$, then the ternions A, can be made to correspond to the lines of R_3 with co-ordinates $P_{01} : P_{02} : P_{03} : P_{23} : P_{31} : P_{12} = 0 : 1 : A_0 - A_1 : A_2 : -(A_0^2 - A_1^2) : (A_0 + A_1)$. (The transformation is not one-one.) By means of this transformation he has shown that the group is identical with the collineation which transforms $\xi_0 = 0$, $\xi_1 = 0$ into itself. Here is a nice geometrical representation of ternions.

He has also shown that the group is holomorphic with the group of the minimal complex—the straight lines having proper intersection with the conic-absolute in an Euclidean R_3.

The first representation of ternions is such that an ∞^2 st. lines of the projective space R_3 did not correspond to ternions at all. Then by considering a geometrical entity as corresponding to a ratio of two ternions, he obtains a representation in which the geometrical entities are points in an affine space; the exceptional points for which ratio of ternions do not correspond belong to a plane which is naturally considered as the special-plane of the affine space (*Uneigentliche-Ebene*). The work is a very striking illustration of the unity in geometry stressed by Klein in his epoch-making Erlangen-Programme.

K. V. I.

Cauchy-Riemann Conditions.

MENCHOFF (*Fund. Math.* **25**, pp. 59-97) has extended Looman's classic result (*Gott. Nach.*, 1923) about the sufficient conditions for the analyticity of $f(z) = P + iQ$ in a given simply connected region. Looman had shown that if the Cauchy-Riemann partial differential equations were valid for almost all points in the region then $f(z)$ was analytic. This amounted to assuming that the derivates in two perpendicular directions (directions same

(*Continued on page 605*)

SUPPLEMENT TO "CURRENT SCIENCE".

Reviews.

An Examination of Examinations. By Sir Phillip Hartog and E. C. Rhodes, D.Sc. (Macmillan and Co., London, 1935.) Pp. 81. Price 1*sh.* net.

The publication of a book called '*An Examination of Examinations*' by Sir Phillip Hartog and Dr. E. C. Rhodes (Macmillan & Co.) has caused considerable commotion in the educational world. The history of the matter goes back to 1931, when, at the instance of the Carnegie Corporation, the Carnegie Foundation and the International Institute of Columbia University, Committees were set up in England, Scotland, Switzerland, France and Germany. These Committees were each financed with a grant for three years, and were requested to carry out investigations regarding examinations on whatever lines seemed best to them. The English Committee was presided over by Sir Michael Sadler, and consisted of educational experts of admitted authority. It determined to compare the marking of the same sets of examination answers by different examiners. The volume under review is an account of the main findings of the English Committee, and the reviews of the book already published in England are unanimous in describing the results of the enquiry as disquieting. Now that this investigation has been made, and its results published, the really surprising thing would seem to be the fact that such an investigation has been so long delayed. Those engaged in educational work have for long been aware that examinations were not a perfect test of the ability of candidates. Sir Phillip Hartog reminds us that at Oxford nearly fifty years ago, Professor Edgeworth conducted a small test concerned with the valuation of a piece of Latin prose by a number of different examiners. The results showed a variation of over fifty per cent. between the highest and the lowest marks awarded. In 1911 Sir Phillip Hartog himself in a lecture given before the Royal Society of Arts recommended that a Royal Commission should be set up to investigate the examination system in Great Britain. Until the work of the recent Committee of enquiry, however, nothing systematic appears to have been done.

In order to carry out their enquiry, the Committee enlisted the sympathy and services of various examining bodies in England. From them it received actual scripts written by candidates for different public examinations. After noting the numerical value assigned by the original examiners, every mark was removed from the scripts. The services of an independent body of expert valuers were then enlisted. These people were in every case persons accustomed for years to value examination papers of the type being investigated. Each of a number of examiners was then asked to value the selected scripts, and the volume under review is an account of the results obtained from this valuation. The Committee selected examinations of widely differing types and standards, in order to test valuation at different stages of the educational process. They selected—

1. *The Special Place Examinations.*

These examinations are held for candidates between the ages of 10 and 12, and on their results children in Elementary Schools gain admittance to Central Schools or Secondary Schools. The importance of this examination to children in England will be evident, when it is realised that the number of candidates every year is estimated to be nearly half-a-million.

2. *The School Certificate Examinations.*

These examinations are conducted by several different bodies in England, and are taken by nearly 70 thousand candidates every year. The average age of the candidates is about 16. Under certain conditions, the passing of this examination qualifies for entrance to the Universities. It may truthfully be said that a boy who is unable to pass this examination is in the vast majority of cases condemned to a poorly paid and subordinate post for the rest of his life.

3. *A College Scholarship Examination in English Essay at one of the Older Universities.*
4. *A University Honours Examination in Mathematics.*
5. *A University Honours Examination in History.*

From the foregoing, it will be seen that the Committee has tested the examination

system at many stages. In the space of a short review, it is not possible to give the detailed findings regarding each of these examinations, but no one engaged in educational work can afford to be ignorant of the information contained in *An Examination of Examinations*. As a sample of the findings of the Committee, we may select the School Certificate Examination in History, as the results in this case display, perhaps, the greatest disparities. Fifteen scripts were selected, all of which had been given the same "middling" mark by a certain English examining authority. The cleaned scripts were sent to fifteen examiners all of whom were in the habit of valuing papers for examinations of this standard. These fifteen examiners awarded no less than 43 different marks, the lowest mark assigned being 21% and the highest 70%. This result is sufficiently disturbing, but worse follows. After an interval of not less than a year, and not more than 19 months, the same scripts were cleaned again, and sent to the same examiners, who were not however, informed of the fact that they were being asked to value the same papers a second time. The result of the re-examination was that the total number of different marks assigned was 44 and the percentage varied from 16 to 71. It was found that nearly half the examiners give a different verdict on each candidate on the second occasion, and one examiner changed his opinion in regard to no less than 8 candidates out of the 15. The astonishing thing about this particular examiner was that he only varied his average mark per candidate by a unit, and that in each batch of 15 scripts, he awarded the identical number of failures. As Sir Phillip Hartog and Dr. E. C. Rhodes point out, such irregularity of judgment is not only formidable, but it is one which would never be detected by any ordinary analysis of valuation results. Statistically this examiner produced almost identical results on both occasions, but the fate he allotted to half the candidates was different. Of all the valuers engaged in this particular examination, only one was exceptionally steady, and his maximum variation between the two valuations was 7%.

Although the results in the other examinations showed smaller discrepancies than in the case quoted above, there was no examination which did not reveal disturbing differences of opinion. Every one will at once ask the question: Should examinations be abolished? The Committee who conducted these investigations answer emphatically in the negative and are of the opinion that examinations as a test of efficiency are necessary, and that no satisfactory substitute can be found for them. Careful and systematic experiments, they point out, will be necessary in order to devise a system of examination valuation which will not be liable to the evident uncertainties of the present system. The President of the Board of Education in Great Britain in reply to a question on 9th December last in the House of Commons, stated that "the Report of the Committee raises questions of great importance that call for and will at once receive full investigation by my department."

During the last decade or more, there has been a marked increase in England in the *viva voce* (Interview) examination. It has been steadily maintained that this test (which is not a *viva voce* on any particular subject) affords a trustworthy opinion of the alertness, intelligence and general outlook of candidates. This interview examination (for which marks are allotted, for example, in the Indian Civil Service Examination, and in that for the Class I Administrative appointments in the British Civil Service) has become more and more popular for all kinds of appointments both public and private. There have, however, always been people, who refused to believe that the interview examination produced the results claimed for it by its enthusiastic advocates. The Committee whose work we are reviewing conducted an examination of this kind. It constituted two such Boards of Examiners. We are not told the names of those who made up the two separate Boards. We are, however, given the list of names of those from whom both Boards were made up. Their names command respect in England, and their competence to fulfil the functions assigned to them would be unquestioned by any one. Despite this fact, Board I examined 16 candidates and selected one as deserving of the first place. This candidate was placed 13th, however, by Board II, its first candidate being placed 11th by Board I.

We have not exaggerated in stating that the results of this enquiry into examinations are disquieting. It is well, however, to preserve a sense of balance, and a little

reflection will show that these results after all merely serve to prove a fact which should be self-evident, namely, the fallibility of all human judgment. Higher Law Courts are constantly reversing the judgments of Lower Courts on appeal. In medicine, the highly qualified specialist will not invariably diagnose a case in the same way as the general practitioner. There is, in fact, no walk of life in which different men will not give different judgments concerning matters on which all are theoretically competent. This being so, we need not be surprised that '*An Examination of Examinations*' has revealed discrepancies in human judgment. The present writer has always felt that examiners should be more carefully selected. It should not be assumed that one who has a competent knowledge of his subject and is a successful teacher of it, is necessarily possessed of that calm balanced type of mind so necessary to enable an examiner to maintain a fair and even standard. It would, at the moment, be obviously a difficult and most delicate matter to subject prospective examiners to a test as to their fitness, but the time may come when such tests will be an accepted part of the machinery of the educational world. India will await with interest the consequences in England of the present enquiry. It seems clear that matters can no longer be left exactly where they are.

E. M.

Marine Zoogeography. *Tiergeographie des Meeres* (Akademische Verlagsgesellschaft, Leipzig, 1935). Pp. 542, 32 Marks.

Prof. Sven Ekman of the University of Uppsala, Sweden, has made a very valuable contribution to biological literature by the publication of his masterly work entitled *Tiergeographie des Meeres*.

The Zoogeography of earth's surface has been dealt with by various specialists, and there are available a large number of excellent publications which contain not only detailed and critical accounts of land faunas, their origins, relationships and distributions, but also deal with the conditions governing life, adaptations of different animals, animal communities, their ecology, etc. In reference to marine faunas, however, the earlier works of even such authorities as Schmarda, Agassiz, Dana, Woodward and Günther, unfortunately lack in some very essential points. In 1896 the masterly volume of Ortmann—*Grundzüge der marinen Tiergeographie*—laid the foundations for detailed marine zoogeographical studies. In this book, Ortmann not only defined the zoogeographical regions into which the oceanic area can be divided, but also discussed the physical conditions governing life in the different regions, the various factors determining the conditions of life in different areas, the *Bionomie*, the peculiarities of the conditions of existence (Moseley) and the adaptations of the organisms for existence in the different *milieus*. In discussing the distribution of the sea animals he dealt with the factors which control and hinder distribution, as also the agencies which govern the distribution of the various organisms. The influence of the geological changes of the earth's surface on the distribution of animals in the different oceans and the changes in climatic, topographical and biological factors for the distribution of the animals were also discussed. Ortmann finally considered in detail the Bionomie and the present day geographical distribution of the Decapod Crabs, and briefly reviewed the distribution of other marine organisms as determined by the various controlling agencies detailed above. Similar but more fragmentary accounts of the distribution of marine organisms are also to be found in oceanographical works such as *Science of the Sea* (Second edition, edited by E. J. Allen, 1928), but as Ekman points out, no work is available in which one can find a comprehensive account of our knowledge of marine zoogeography.

The first ten chapters of the work under review deal with the faunas of the different oceanic areas, their origins, relationships, compositions, etc. In view of the great importance of this part of the subject a somewhat detailed summary of these chapters is given below. The remaining six chapters deal with the "Meridiane Verbreitung" or the distributions of special genera or species along definite meridians of longitude or latitude, Bipolarity problem; Benthal Deep-sea Fauna, its composition, conditions governing its existence, regional distribution, and origin; and the Pelagic Fauna of the upper and deeper layers, its horizontal distribution, its relationships to salinity, etc. In the final chapter are discussed the adaptations of animals to deep-sea life, such as the development of special light organs, special enlargement, or reduction in the size of eyes culminating in the animals becoming absolutely

blind, uniform colouration and the enlargement of the mouth opening, special development of teeth, increase in the size of stomach, taste-organs, prolongation of antennæ, fin-rays, etc. The horizontal distribution of the bathypelagic fauna and its origin are also discussed.

In conclusion the author remarks that the geographical distribution of the organic world seems to be determined by the physiological peculiarities of the animals as regulated by the chemico-physical reactions of the surrounding world. Evolution along divergent lines in widely separated localities is the essence of biogeographical distribution and its earlier manifestations are the discontinuity in the distribution of different classes of animals in adjacent areas.

In connection with the present-day disposition of the faunas of different areas modern work has clearly brought out the importance not only of studies regarding the influence of organic evolution but also of the changes in the earth's surface and climate during the past geological epochs. As a result it has become necessary to consider as intimately the geological and historical influences as the ecological and faunistic factors which determine the zoogeographical distribution in any area.

Ekman starts with a discussion of the Tropical Littoral Fauna which shows a marked general homogeneity in the circumtropical region. The tropical fauna is very rich, much richer than that of the colder regions, and is probably the source from which the faunas of the colder seas originated. The detailed treatment of this fauna is prefaced by a general account of the life and the animal associations which are found on coral reefs, and a short discussion of the theories of their origin and distribution. The other important faunistic association of the littorals of the tropics, the Mangrove fauna, is similarly discussed and its characteristics briefly outlined.

The littoral fauna of the tropics is treated under three main heads: (*a*) the Fauna of the Indo-Pacific, (*b*) the Fauna of Tropical West Africa, and (*c*) the Fauna of Tropical America. Of these the fauna of the Indo-Pacific, which is the richest and most diverse, is sub-divided into Malayan, southern central Pacific, Hawaiian, Southern Japanese, Australian, tropic and sub-tropic, and finally that inhabiting the north and western areas of the Indian Ocean. The extent and boundaries of the different areas are discussed and their faunal characteristics enumerated. The littoral fauna of Tropical America which is distributed along the two coasts of Central America in the Atlantic and Pacific Oceans, shows marked similarities, as a result of which in spite of the Panama Land bridge the fauna of this area constitutes a single entity; this is to be explained by an open connection between the Atlantic and Pacific Oceans throughout the Palæozoic and the Mesozoic times and possibly also in the early Tertiaries. The endemic elements and the relationships of this fauna with that of the Indo-West Pacific Fauna are discussed in detail and this is followed by a description of the fauna of the Tropical West Africa on similar lines. Finally it is suggested that the boundaries of the Tropical Littoral Fauna are determined by climatic factors, of which, according to the author, "the temperature is one of the most important zoogeographic factors for the development of the marine fauna".

The past history of this Fauna and its origin are discussed and in this connection reference is made to the Tethys Sea which encircled the globe during the Cambrium and was present with slight changes in its extent and course up to the Middle Tertiaries. As a result of detailed geological studies the conclusions arrived at are as follows:—

(1) During the Cretaceous and early Tertiaries a very rich littoral fauna of the tropical-type was widely distributed in the European Seas. Most of it has become extinct in these parts, to a great extent in the Atlantic Ocean and to some extent all over the world.

(2) The Atlantic Fauna of the early Tertiaries was markedly of the Indo-West Pacific type; this was particularly the case with the Mediterranean Fauna.

(3) The West Indian Fauna during the Eocene and Oligocene periods showed much closer conformity with that of the Indo-West Pacific area than is the case at the present day.

(4) There was in the earlier geological periods a much greater conformity between the faunas of the eastern and western Atlantic. This disappeared to a great extent as a result of the extinction of the majority of the tropical types in the eastern Atlantic Ocean.

The changes in the fauna of this vast area are intimately connected with climatic changes during the Tertiaries. The elevation

of large masses of land in Central America and West Asia coinciding with the adverse climatic changes during Miocene and Pliocene was the determining factor for the later changes in the Tropical Littoral Fauna. From then on was gradually evolved the present-day distribution of the zoogeographical elements resulting in the great contrasts between the Indo-West Pacific fauna and the Atlantic-East Pacific fauna. The development of the faunas took place along new lines from the Middle Tertiaries onwards.

The present-day fauna of the Mediterranean extends into part of the mid-Atlantic along the Moroccan and Mauretanian areas and the Macronesian Islands such as the Canary Islands, Cape Verde, Medeira and Azores, and Ekman designates this region as the Mediterranean-Atlantic. The Mediterranean is evidently a section of the Atlantic, but this does not mean that all its faunistic elements are to be derived from the recent Atlantic fauna. On the other hand, several of its components are the remnants or relics of the Old Tethys Fauna. In addition, since 1869 when the Suez Canal formed an open communication between the Mediterranean and the Red Sea, a large number of erythrean forms have wandered into and established themselves in the Mediterranean.

The Sarmatic fauna which is rightly treated separately by Ekman, deals with the remnants of the inland Sarmatic Sea of the Upper Miocene and later times. Its present-day representatives are the Black Sea, the Sea of Azov and the Caspian Sea. The recent faunistic elements of the Black Sea are, in the main, of Mediterranean origin, but the Sea of Azov and the Caspian have retained more of the older elements. The Tethys fauna, however, does not consist of purely marine forms, but of brackish-water organisms or at least of very euryhaline animals.

The influence of the central Atlantic barrier does not seem to have been very marked in determining the North-Atlantic Littoral Fauna, and the author is, therefore, justified in considering the littoral fauna north of the Bay of Biscay in European waters and the Cape of Hatteras in American waters as a single unit. On practical grounds, however, he deals with the European and American faunas of the areas separately.

The European North Atlantic Fauna is treated under two distinct sub-heads :— (1) The Atlantic Fauna proper, and (2) The Fauna of the Baltic Sea and other brackish-water areas. In either case the hydrographic influences such as temperature, salinity and other factors are discussed and the composition of the fauna from the point of view of its elements such as endemic, northern Mediterranean and northern Arctic, etc., elucidated. In the case of the deeper waters the fauna differs with the substratum, that of the hard sea-bottom being different from that inhabiting a soft muddy bottom. The effects of temperature of the sea waters on reproduction and development resulting in the wider distribution of the animals are also discussed, and according to their reaction to this factor the animals are classed into eurythermic, stenothermic and warm stenothermic forms. The salinity of the waters also plays an important rôle in the reproductive activities of these animals. As examples may be cited the fishes of the family Gadidæ investigated by Damas. The widely distributed north Atlantic forms such as *Gadus morrhua*, *G. æglefinus*, etc., prefer temperatures of 4-6° C., a salinity of 34–35·2 per mille and a depth of 40–200 metres for depositing their eggs. The southern boreal species *G. esmarkii* breeds in 6° C., salinity of 35–35·2 per mille and at depths of 60–200 metres. The Mediterranean-Atlantic and boreal species such as *G. minutus*, *G. luscus* and *G. pollachius*, on the other hand, breed in a temperature of over 10° C., salinity of 32–35·35 per mille and a depth of less than 100 metres. In the Baltic Sea and other brackish-water areas there are, in addition to the pure marine types, a great variety of true estuarine species and several essentially fresh-water animals in the inner regions. The history of the changes in the extent of this area during the past geological ages is discussed, and the influence of periodic glaciations in determining the fauna elucidated. The main relics of the glacial periods are the brackish and fresh-water organisms, the extreme euryhaline species and certain marine and brackish-water animals occurring in isolated brackish-water areas, fjords, etc.

The American North Atlantic Fauna is treated on similar lines, but the information about this area is less complete. The general conclusion arrived at, however, is that the faunas on both sides of the Atlantic Ocean show greater affinity with those of the Arctic and sub-Arctic regions than with that of the intermediate northern and southern areas.

The North Pacific Fauna of the Temperate Zone is found north of Central Japan and along the middle of the southern part of the Californian Peninsula; these form the northern boundary of the Tropic-subtropic Littoral Zone. This Fauna, though it exhibits a certain admixture of tropic-subtropic forms in the southern zone, is entirely different. One finds here a very rich and distinct endemic temperate element with a number of forms of the temperate-Arctic type. The dominance of this Temperate Zone element, which is much more marked on the west coast, is to be explained by the convergence of the isotheres along the western coast, where, as a result, a very marked endemic element of a well-characterised Temperate Fauna predominates. Qualitative and quantitative comparisons of the North Pacific and North Atlantic Fauna bring out the fact that North Pacific Littoral is 6–8 times richer in endemic species than the North Atlantic; the same is the case with endemic genera. The North Pacific is, further, characterized by having endemic families. Reference may also be made here to the discontinuity in distribution of several types in the two areas. The common cod of the Atlantic *Gadus morrhua*, is represented in the Pacific by a nearly allied species *G. macrocephalus*; some ichthyologists, however, consider the Pacific species to be identical with the Atlantic. Similarly the halibut of the Atlantic, *Hippoglossus hippoglossus* is represented in the North Pacific by *H. stenolepis*. Invertebrates show similar discontinuous distributions, and these forms are designated as circumboreal or amphiboreal animals. Their present-day distribution is to be traced to the past times when the species or genera had a continuous distribution throughout the whole regions, but later as a result of climatic changes, the chain was broken and the distribution became discontinuous. Here also glaciation was a very important factor in determining the present-day distribution.

The Arctic fauna is dealt with in great detail and the conclusion arrived at is that the northern hemisphere has mainly two types of faunas, *viz.*, a tropical and a northern, and the northern fauna is sub-divided into that of the Temperate Zone and the Arctic region. The faunas of these two sub-zones show very close relationships; in some cases the Arctic appears to be the ancestral type, while in others the Temperate Zone forms must be considered as the parental forms. As a result, Ekman is also of the opinion that both these faunas may have originated from a common ancestor. Two important peculiarities of the Arctic Fauna to which attention may be directed are: (i) along the coasts up to a depth of 4–5 metres the waters, as a result of the very low temperatures, due to the floating ice, harbour remarkably few, if any, animals, and (ii) the correctness of Thienemann's Rule—that whereas the animal communities (Biozonose) of an area (Biotope) become poorer in the species represented with the greater specialization in reference to the conditions determining life in the area, the number of individuals of such species, however, becomes comparatively very much richer, is proved beyond any doubt.

In discussing the fauna of the southern hemisphere below the tropics, Ekman deals with the fauna of the southern Temperate Zone—which is sub-divided into that of (i) South and West African; (ii) South Australian and New Zealand; and (iii) Peru and Southern Chili—separately from that of the colder southern hemisphere. In the latter are included the Kergulean Archipelago, the Antiboreal South American area and the Antarctic Zone.

The fauna of South and West Africa shows very distinct affinities with that of the Indo-West Pacific; but here also there are indications of relationships with the fauna of the Atlantic. The fauna of New Zealand is very closely allied to that of South Australia, and both these show very close relationships with the Indo-West Pacific fauna. The relationships of the fauna of Peru and Southern Chili are not clear, but its relationships with the faunas of the northern area are indicated by the molluscs and crustacea, which have been studied in some detail.

The fauna of the Kergulean Archipelago corresponds to that of the sub-Arctic area of the northern hemisphere, and may, therefore, be designated as the sub-Antarctic fauna. In addition to endemic elements there are types which show distinct affinities with the South American and others with the Antarctic types. The Antiboreal South American fauna shows close relationships with that of the adjacent northern area, but the influence of glaciation makes it rather difficult to elucidate its exact relationships. The Antarctic fauna is, as a result of the isolation of the Antarctic area, particularly rich in

endemic types; the number of such genera, however, is much smaller than that of the species. The isolation of the area, it may be remarked, is not only geographic but climatic as well, and these factors naturally have greatly contributed to the development of endemic types. The relationships of this fauna with that of the Kergulean and the Antiboreal South America are indicated by the sea-urchins and Ascidians which have been studied by Mortensen and Hartmeyer respectively. A comparison of the Antarctic fauna with that of the Arctic is included in the discussion of the Bipolaritat problem and no further reference to it is necessary here.

The work under review is beautifully produced, with a very large number of excellent illustrations, charts and drawings, and will be indispensable as an authoritative source of reference for marine zoogeographic work. The bibliography at the end of the work is fairly extensive, and the only criticism that may be offered here is that it does not include the very extensive work of the R. I. M. S. "*Investigator*" in the Indian seas mainly published by the Trustees of the Indian Museum and the Zoological Survey of India in a large series of monographs and serial publications.

B. P.

A History of Science and its Relations with Philosophy and Religion. By William Cecil Dampier-Whetham, M.A., F.R.S. (Cambridge University Press, 1935.) Second Edition. Pp. xxi+514. Price 8*s*. 6*d*. net.

This is a great and scholarly work which it is both a pleasure and a privilege to read. The component parts of the imposing structure of modern science have an evolutionary history, the narration of whose orderly progress amounts practically to recording the struggles of the human mind in its quest of truth. Long before man began to investigate the facts and phenomena of the objective world, he had formulated definite theories and doctrines of his subjective experiences, and for a short time, not long ago, it looked as though they would crumble under the achievements and conclusions of the investigations of the physical and biological sciences. We have in modern times practically returned to the ideas of the old Greeks to whom philosophy and science were one.

Science adopts analytical methods of investigation and mathematical forms of expression of the physical concepts, and these fundamental concepts whether they belong to the realms of the physical or biological science, are now tending to abstractions. The scientific method of approach to the ultimate reality can only reveal certain aspects of it, and philosophers are now recognising that their metaphysical concepts of nature must lack validity when not founded on the evidence of the experimental sciences. The interactions of the different modes of thought naturally reduce the complexities of phenomena to order and simplicity, leading to the discovery of a new realism built up by their means.

We know that civilisation first appeared in the valleys of the great rivers, the Euphrates and the Tigris, the Indus, and the Nile, and knowledge, which must have been crude and empirical at the dawn of history, associated the physical phenomena with the works of beings as capricious as man, but higher in order; and the desire to reproduce those phenomena naturally expressed itself in the practice of strange rites, magic and animistic beliefs. Magic, religion and astrology thus formed the foundations of science. The first attempts to introduce order and rules of measurement were made by the Greek nature-philosophers of Ionia as is evidenced by their efforts to convert the empirical rules for land surveying derived from Egypt into the deductive science of Geometry, the beginnings of which are assigned to Thales of Miletus and Pythagorus of Samos. The nature-philosophers sought reality in matter, and developed the theory of primary element, culminating in the atomism of Leucippus and Democritus. On the other hand the Pythagoreans saw reality in form and numbers, and, later when the Athenian school of Socrates and Plato developed metaphysics, the study of nature was replaced by the study of self, culminating in the development of the theory that ideas alone possessed reality which was denied to the objects of sense. Aristotle returned to observation and experiment at least in biology, but in physics and astronomy he followed the metaphysical doctrines of his master Plato.

During the Roman Empire science ceased to advance, but the Early Fathers of the Church produced a sort of Christian synthesis from their doctrines and those of

Neo-Platonic philosophy and the elements derived from the Oriental Mystery Religions. During the Dark Ages, learning, mainly Greek learning, was confined to the monks, though an Arab school arose, which made contributions to natural knowledge.

In the thirteenth century the scholasticism of St. Thomas Aquinas produced alternative synthesis which, based on the Aristotlian philosophy, gave a new rational scheme of knowledge in which Christian doctrines were blended with Aristotlian science. Scholasticism through the Middle Ages upheld the supremacy of reason, teaching that God and the Universe can be comprehended by the human mind. The way was thus paved for science, which holds that nature is intelligible. The scholastics were the forerunners of modern scientists whose appeal is only to verifiable facts. Scientists do not accept authority as the Scholastics did, but rely on observation and experiment as the ultimate sources of knowledge or as the means of approaching reality. In accepting a system of philosophy on authority, scholastics made full use of reason, examined the logical basis of premises and the validity of deductions in their relation to Christian theology and Aristotlian science. To the scientist observation and experiment are the starting points and final arbiters, and their methods are somewhat like those employed in fitting together pieces or words of a puzzle. To Aquinas and his contemporaries the real world was that disclosed by the senses, and they were unaware of the perplexities of the theory of knowledge and the difficulties underlying the concept of matter in motion by a non-material and non-extended mind which appeared for the first time under the analysis of Galileo.

The work of Galileo was consummated by Newton whose science was converted by his enthusiastic followers into a mechanical philosophy under which man became a machine. The first step to escape from this mechanism was taken by Kant and Hegel who in German idealism derived from Plato, succeeded in separating science from philosophy. This mechanical outlook first promoted by the physical sciences, seemed to extend to the biological sciences when in the second half of the nineteenth century Darwin formulated his Special Theory of Evolution. Man was reduced to a link in the chain of organic development. It became easy for most men of science to hold that physical science revealed the reality of nature and they had little regard for idealist philosophy.

> "Physical science represents one analytical aspect of reality; it draws a chart which, as experience shows, enables us to predict and sometimes to control the workings of nature. From time to time great syntheses of knowledge are made. Suddenly bits of the puzzle fit together, different and isolated concepts are brought into harmony by some master mind and mighty visions flash into sight—Newton's Cosmogony, Maxwell's Co-ordination of Light and Electricity or Einstein's reduction of gravity to a common property of space and time. All the signs point to another synthesis, in which relativity, quantum theory and wave-mechanics may fall into the all-embracing unity of some one fundamental concept."
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> "At such historic moments physical science seems supreme. But the clear insight into its meaning which is given by modern scientific philosophy shows that by its inherent nature and fundamental definitions it is but an abstraction, and that, with all its great and ever-growing power, it can never represent the whole of existence. Science may transcend its own natural sphere and usefully criticise some other modes of contemporary thought and some of the dogmas in which theologians have expressed their beliefs. But to see life steadily and see it whole, we need not only science, but ethics, art and philosophy; we need the apprehension of a sacred mystery, the sense of communion with a Divine Power, that constitute the ultimate basis of religion."

This high note sums up the outlook of this great book, to read which is a liberal and intense education in science and philosophy, and as the reader progresses in his study, his experience and knowledge are exalted into the higher planes of idealism. This is a great book worthy of a great mind.

An Introduction to Astronomy. By Robert H. Baker. (Macmillan & Co., London, 1935.) Pp. 522. Price 15 *sh.*

The book is written to serve as an introduction to Astronomy. The reader is expected to possess very little equipment in the way of previous study intelligently to read the book. The book is written in an attractive style so as to create an interest in the reader for the fascinating subject of Astronomy. Hardly any mathematics is used in the treatment. But this is not always an advantage, for the author in the absence of even simple mathematics cannot but make his account here and there carry little meaning to the reader. An instance in point is the treatment of "Doppler Effect". A short section covering less than half a page is devoted to it. The beginner

cannot appreciate the significance of the following sentence without further elucidation.

"The Doppler effect permits the astronomer to determine how the stars are moving towards or away from the earth, to observe their rotations, pulsations and explosions and to detect closely revolving pairs of stars which the telescope cannot separate."

On the whole we think the author has done well in omitting mathematical treatment in a work intended to be an introduction to Astronomy. The whole book is eminently readable and provides genuine enjoyment. In this connection one is inclined to draw particular attention to Chapter XIII "Within the Milky Way". We have no hesitation in recommending the book to beginners in Astronomy and to all those who wish to have an intelligent understanding of the fundamentals of a subject which no one claiming to be cultured can afford to ignore.

Industrial Electronics. By F. H. Gulliksen and E. H. Vedder, Members A.I.E.E. (John Wiley and Sons, Inc. New York, Chapman & Hall, Ltd., London, 1935.) Pp. xiv + 245. Price 17*sh.* 6*d.*

Many important types of industrial applications in which electronic devices are used, are now being extensively employed. A knowledge of the electronic apparatus and its working is therefore essential to an applied physicist or a practical engineer. The book by F. H. Gulliksen and E. H. Vedder supplies us with such a knowledge. Most of the important electronic devices in industrial technology are very ably and carefully described with an expert knowledge on the subject. Different kinds of tubes, their characteristics and some fundamental circuits are also briefly given before describing the elaborate and sometimes complicated circuits employed in commercial electronic instruments and control equipments and their applications which form the subject-matter of this very useful book. The type of equipments primarily used for wireless communication purposes, *viz.*, modulation, detection and amplification of high-frequency signals, is, however, left outside the scope of the book. A very brief outline of the methods generally employed for such wireless communication purposes would have been very useful.

The book is divided into four parts. The first two parts are of an elementary nature and give more or less up-to-date information about the different kinds of electronic tubes and some fundamental circuits associated with them. In Part I the authors have classified the electronic tubes into three general classes. The first class is light-sensitive, the second high-vacuum and the third gaseous. A brief description of the three classes of tubes is given with the specific object of illustrating their working in different applications. The chapter on gas-filled tubes is comprehensive. Besides the rectifying tubes, it deals with some representative grid-controlled and ignite-actuated tubes. In Part II some fundamental circuits for high-vacuum amplifiers (low-frequency) and for grid-controlled gas-filled tubes and ignitrons are shown. With regard to high-vacuum amplifiers, the different methods of multi-stage low-frequency amplification are briefly given. The triode as an oscillator is very inadequately dealt with—although the circuits given for ordinary oscillating tubes and the multivibrator will be of practical value. The control circuits for grid-controlled gaseous discharge tubes and for the ignitrons will also be found very useful. While setting out the circuit diagrams, it appears the authors have assumed a knowledge of the fundamental physical principles on the part of the readers. A brief exposition of these principles in the first two parts, however, would have greatly facilitated the understanding of the last two parts—especially for the beginners who want to gain a working knowledge on the subject. The lack of proper emphasis on the physical principles is, in fact, a criticism which applies more or less to the whole of the book. It is needless to say that the fundamental principles clearly set out, not only help the understanding of the practical working but also give a broad and comprehensive view of the subject. It is hoped the authors will include in the next edition a short and clear exposition of the Physics of the subject, especially in Parts I and II which are regarded as a prelude to the remaining two parts.

Part III is devoted to commercial electronic instruments and control equipments and their applications. Among the light-sensitive control devices, photo-electric relays and their applications, elevator floor levelling, elevator door safety control, automatic control for artificial lighting, Louvre controller, door controller, sorting, grading and

matching will be found very interesting and useful. Only such details are given as are necessary for the understanding of the actual working of the appliances. Among the Indicating and Recording devices, the most important instrument described is the cathode-ray oscillograph which covers a wider field of applications than the mechanical oscillographs, for it can be used for the study of electric phenomena at radio-frequency, whereas the mechanical oscillographs are limited to about 10,000 cycles. The description of the working of the cathode-ray oscillograph, however, is not complete, since the authors have kept the subject of radio-frequency outside the scope of their book. Some useful and practical circuit-diagrams are given for the oscillograph work. Such useful recording devices as Smoke Indicator, Transmittency Instrument, Colour Matcher, Telemetering, etc., are explained with diagrams. The chapter on Rectification and frequency conversion deserves special commendation. It deals with rectifiers for low power and low voltage, mercury-arc rectifiers, ignitron-rectifiers and electronic inverters. The diagrams of circuits and of wave shapes of rectifier voltages and currents are shown. The fundamental relations between transformer voltage and output voltage for single-phase, three-phase and double three-phase circuits for ideal conditions with a resistance load have been clearly indicated so as to give a conception of the factors involved in the circuits. Circuit diagrams for electronic inverters have been clearly set out. Industrial applications of these electronic inverters, there will be many in future when there will be a considerable reduction in the price of the tubes. The chapters on the Control of Resistance Welders and Theatre and Mobile Lighting control will be of interest and help to those electrical technicians who work along these lines. Under miscellaneous applications, Oil Burner control, Train control and Cab Signalling, Resistance and Contact control devices in many industrial concerns are discussed. Precipitation rectifiers and Industrial X-ray equipment are also dealt with.

The chapter on Electronic Relays will be very much appreciated. We find in it the most modern applications of the Electronic relay equipments. Electromagnetic types of relays will soon be replaced by these electronic relays which are characterised by low consumption of control energy, quick response action, absence of contacts and moving parts and flexibility in circuit design and adjustments. All the sections in this chapter, *viz.*, Automatic synchronisers, Time-Relays, Cycle-Splitters and protective relays, show evidence of first-hand knowledge of the modern electronic equipments.

Part IV deals with Electronic Regulators. The automatic regulators are generally of the electromagnetic type. The introduction of the electronic regulators has extended the possibility of regulator applications especially in the industrial field. After setting out the fundamental principles of automatic regulator design, the authors describe the following chapter by chapter:

Voltage Regulators,
Speed Regulators,
Photo-electric Register Regulators,
Calorimetric Regulators,
Temperature Regulators.

All the chapters are full of useful, up-to-date and practical informations based on expert technical knowledge of the subjects.

Recent developments in Industrial Electronics are to be found scattered in different scientific and technical journals. Gulliksen and Vedder's book will be a very useful compendium of all the important modern developments. References to original papers appended at the end of each chapter add considerably to the value of the book. Insufficiency of details or vagueness at times due to the brevity of treatment has been amply compensated by these references.

To the applied physicists and electrical engineers the book will be of immense practical value.

S. R. KHASTGIR.

Experimental and Theoretical Electrochemistry. By M. Dole. (McGraw-Hill, London, 1935.) Pp. 549. Price 30*s.* net.

In its widest sense Electrochemistry includes all chemical phenomena, since there is probably no form of chemical energy which is not essentially electrical in origin and no chemical phenomena of which the origin cannot be traced to an electrical effect. Dr. Dole, however, limits electrochemistry to chemical knowledge which has been obtained by experiments involving the application of electric or magnetic fields. This definition emphasises the experimental side of electrochemistry and indeed this book has definitely an experimental bias.

Some of the subjects included in older books such as the theories of indicators, of neutralisation, and of buffer solutions have been omitted; from the author's point of view they are outside the domain of electrochemistry. But their place is well taken by discussions of such interesting and important subjects as dipole moments, molecular rays, high frequency and high voltage conductance, electrokinetic and electrocapillary phenomena, and phase boundary and semipermeable membrane potentials. A good deal of space, as is natural, is devoted to conductance of electrolytes. The discussion on concentration cells is adequate and, from the student's point of view, is greatly improved by the inclusion of a chapter in which the fundamentals of thermodynamics are clearly outlined. The chapter on the glass electrode is a valuable addition, as this new type of hydrogen electrode has not been adequately treated in older text-books.

The book is well and clearly written, there are a sufficient number of references to the original literature to guide the student in the extension of his reading, the diagrams are clear and illustrative and the proof reading has been carefully done. The author is to be congratulated on having produced a text suitable in every way for use by Honours degree students.

T. S. W.

Probability and Random Errors. By W. N. Bond, M.A., D.Sc., F.Inst.P. (Messrs. Edward Arnold & Co., London, 1935.) Pp. 141. Price 10*s*. 6*d*. net.

One of the most useful and potent tools of laboratory practice, to-day, is a knowledge of Probability and Random Errors. Experiments may be planned and carried out, results may be obtained and interpreted, and conclusions arrived at; but unless the reliability of the results is ascertained, the conclusions may remain in a state of doubt. Attempts to confirm the results, by repetition of the experiments may be made, where they are really not required, and no such attempts made at all, where they are required to be made. In such cases, and in many others, in social, biological and physical sciences, the application of Probability and Random Errors is very essential.

As the author himself points out in his introduction to the book, it is as important to state the probable degree of accuracy of results as it is to state what is measured and the units in which the results are measured. A knowledge of this branch of mathematics is therefore very useful to the student of any branch of science. A number of books on the subject, which require a considerable knowledge of mathematics on the part of the student, are available. But, for a student specialising in any particular branch of science, a book like the present one with a non-mathematical treatment of the subject-matter is very welcome indeed. The author has done great service to science by providing this useful book for the use of research workers. Though the book is mainly meant for the use of students of physics and chemistry, students of other branches of science could also use the book with great advantage. The subject is dealt with in a simple and understandable manner; with a working knowledge of mathematics, the matter dealt with in the book can be followed and understood. The large number of worked examples given in the book add to its usefulness to the student.

Analytical Chemistry. Vol. II. Quantitative Analysis. By F. P. Treadwell and William T. Hall. (Chapman & Hall, London, 1935.) Pp. 858. Price 30*s*.

So familiar and so useful is Treadwell and Hall's *Analytical Chemistry* (both qualitative and quantitative) to the student that it is hardly necessary to dwell on its merits. This brief review will serve no more than as an announcement to the appearance of the eighth edition of the second volume,—quantitative analysis. The book has been entirely reset and brought up-to-date. New and well tested methods have been described for the estimation of columbium, tantalum and certain other metals and much useful recasting has been done to improve the work.

It is difficult to review a book of this type. The best test of the excellence of a book is its popularity and judged by this standard, there is no doubt that the book occupies a pre-eminent place in the analysts' library. It would be ungrateful to try to point out any errors in a book of this importance but one is tempted, however, to mention that on page 78 under Gunning's method for determining nitrogen, it is mentioned that potassium sulphate is used as a catalyst

in the place of mercuric oxide originally recommended by Kjeldahl. This is not so; potassium sulphate serves to raise the boiling point of sulphuric acid and the digestion proceeds much faster than when sulphuric acid alone is used; a catalyser is still necessary and a small quantity of $CuSO_4$ or mercury or manganese dioxide is generally added. On page 77 under the procedure for Kjeldahl's method for determining nitrogen, it is mentioned that "2–30 ml. of concentrated sulphuric acid" should be added to a weighed quantity of the substance in the digestion flask. This is obviously a printer's error for 20–30 ml. No one will recommend the addition of 2 ml. to 0·7–3·5 gm. of substance in a 500–600 ml. Kjeldahl flask!! These errors are very minor indeed.

The binding and general get-up of this enlarged and revised edition are in the familiar style and are of the usual excellence.

Die Forstbenutzung (Forest Utilisation). A Text-Book and Hand-Book founded by Dr. Karl Gayer, Professor in the University of Munich. Thirteenth Edition (in the German Language) rewritten by Dr. Ludwig Fabricius, Professor of Sylviculture and Forest Utilisation in the University of Munich. (Berlin, Paul Parey.) Pp. 758. 8 vo., with 418 illustrations in Text and two colour plates. Price in India 25·50 Gold Marks.

The fact that Dr. Gayer's *Die Forstbenutzung* was first published in 1863 and now appears in its thirteenth edition is eloquent testimony to its continued usefulness. During the period of nearly three-quarters of a century since its first publication, the practice of Forest Utilisation has undergone many and occasionally revolutionary changes. "Minor Forest Produce" have assumed increasing importance. The different editions of Dr. Gayer's work have faithfully covered all these changes. The book has been fortunate in its Editors who have kept up the high standard of the original in being at once thorough and up-to-date. In a very special sense, therefore, these editions mark definite steps in the theory and practice of German Forest Utilisation. The book under review, appearing after an interval of 15 years (the twelfth edition appeared in 1921) is a worthy successor to a very distinguished heritage.

Prof. Fabricius has not altered the general plan of the book. "Wood" being by far the most important Forest Produce has occupied the Part I of the volume. The requirements of the Wood Cutter and the wood working implements have been clearly described, after which are given the methods of felling and storage of wood. This is followed by detailed accounts of the conversion of wood into finished and semi-finished products in saw-mills, workshops, cellulose-, paper- and artificial silk factories, in wood-gas plants and what is perhaps most interesting, in wood sugar plants.

Part II of the book, is devoted to Minor Forest Produce and deals with such varied products as Bark and Vegetable tannins, resins, fruits, fodder, litter, peat and other forest produce. The author has throughout kept before his reader the fundamental maxim that in Forest Utilisation—as in any other sound commercial enterprise—the capital must never be allowed to depreciate.

It is characteristic of German thoroughness that forest utilisation is also considered in relation to national economy. When times are so unsettled politically and when the desire, for national self-sufficiency is degenerating to an insane craze, the intelligent utilisation of forests may prove vital to the very national existence. This is the justification for the inclusion in the book of such modes of utilisation as Wood carbonisation, Resin tapping, etc., which although obsolete in Germany at present, may leap into prominence during an emergent period of stress.

The exposition in the book is very clear. No one who has had the privilege of hearing the Professor's lectures would expect anything else. The gift of the true teacher—that of putting himself in the student's place—is manifest throughout the book. This enhances the value of the volume as a "Text-Book." The carefully analysed description of contents at the beginning and the elaborate index (there are some 2000 guide words) at the end of the volume justify its sub-title—A Text-Book and Hand-Book.

Prof. Fabricius' *Forstbenutzung* is a fine example of German Scholarship at its best. It would be sad if the language difficulty should render it inaccessible to Indian foresters. Such books make one sigh for an Esperanto that would sweep away the clumsy barriers of mere language.

EMMENNAR.

for every point) of $f(z)$ were equal. Now Menchoff has proved by a very intricate analysis that we can have this broader criterion, *viz.*, the derivates in any two directions at almost all points (the directions not necessarily the same for every point) in the region are to be equal. Perhaps, it is interesting to remark that although analyticity can be stated in a form not involving the idea of an integral still there is no proof of this classic result without the *via media* of Cauchy's theorem. It is any way a mystery.

K. V. I.

A New Method for the Study of the Stark Effect.

As is well known there are two methods for the study of the Stark effect, *viz.*, that due to Stark himself and the Lo Surdo method. In the former molecular spectra cannot usually be excited and even atomic spectra are weak in intensity. In the latter there is the advantage that only one source of current is used and high intensity of the spectra is obtained, but because of the inhomogeneous field employed, the measurement of the field is difficult and an astigmatic spectral apparatus like the Rowland concave grating can be used only under limitations. W. Steubing and T. A. Shaeder (*Ann. d. Phys.*, 1936, **25**, p. 97) have designed an apparatus in which great intensity is reached both in atomic and molecular spectra and in which the field strength can be accurately measured. The principle made use of is that by employing a *hollow cathode* closed on the side opposite to the anode by a sieve, the arrangement of Stark can be employed without undue heating of the anode at even high pressures. The intensity of the light excited between the cathode and an auxiliary electrode employed to produce the required electric field depends on the size of the holes in the sieve so that the correct size of holes for the maximum light intensity has to be determined. Filter pumps, mercury pumps and two stage diffusion pumps were used in combination and the pressure was measured by means of a McLeod gauge. The gas to be investigated was let into the apparatus through a needle valve and sucked out by the pumps. The main discharge was produced by two generators each giving two kilovolts and the current employed was 90 mA. The applied voltage was from 3 to 3·5 kv. while the fall of potential within the discharge was 300 to 800 volts. In order to keep the field between the cathode and the auxiliary electrode constant when the current in the discharge varies a special stabiliser was employed. The anode was cooled with water. Special arrangements were made to prevent a discharge taking place between the cathode and the auxiliary field-electrode. The construction of quartz, glass and metal discharge tubes is described in detail in the paper. The experimental results in the case of H, He (atomic), H_2, N_2 and O_2 (molecular) spectra are given. Thus the investigation of the Stark effect of molecular spectra has been rendered easy by the construction of this new type of apparatus and it represents a considerable advance in the technique of Stark effect measurements.

T. S. S.

A New Method for Obtaining Perfectly Polished Metal Surfaces.

THE ordinary method of polishing metal surfaces with emery paper of graded fineness leads to unevenness and under the microscope even the best polished surfaces show scratches. Now P. Jacquet (*Comptes Rendus*, 1935, 201, 1473) gives an electrolytic method of polishing which gives a surface free from any scratches. Photographs given by the author show that the surface appears smooth even under a magnification of 1200. The process adopted is as follows: The metal to be polished is made the anode and immersed in an aqueous solution of ortho- or pyro-phosphoric acid containing at least 400 grams of the acid per litre and maintained at a temperature between 15° and 25° C. The cathode is a copper plate of greater area than the anode. The potential difference between the ends of the cell is measured by means of a sensitive voltmeter and an ammeter and rheostat are included in the circuit. As the resistance is gradually decreased, the voltage between the ends of the cell increases at first while the current density remains constant, then the current density increases rapidly with increasing voltage up to a certain value but afterwards diminishes while the voltage is still increasing. We next come to a stage when the current density remains constant while the voltage rises from a value V_1 to V_2. If the resistance is further decreased the current density increases rapidly with increase in voltage and bubbles of gas are given off in greater and greater abundance. If the voltage is kept somewhat below V_2 so that no bubbles are formed, the metal surface becomes finely polished. If V_2 is exceeded the surface

becomes spotted and so care should be taken to keep the voltage below V_2, say at 1900 volts if gas bubbles are given out at 2100 volts. The current density corresponding to this voltage depends on the concentration of the solution and on the position of the anode. Thus with a solution containing 530 grams of H_3PO_4 per litre, one surface of a copper plate anode whose other face is protected by varnish becomes polished with a current density of 10 ampères per square decimetre if kept vertical, while if it is horizontal and below the cathode, a current density of 6 ampères / dm.^{2} suffices. Besides keeping the voltage below V_2, filtered solutions should be used and any gas bubbles forming on the plate when it is immersed in the solution must be avoided. In this way a plate of copper which, when polished with emery paper No. 05, showed bad scratches under a magnification of 1000, showed a perfectly smooth surface even under a magnification of 1200 when it had undergone the above treatment for 15 minutes.

Shape of String-like Amphoteric Ions in Solution.

THE dielectric constant of a solution of amphoteric ions increases with the concentration according to the law $\frac{d\,D}{d\,c} = k\,z$ where z is the number of chain units between the NH_2 and COOH groups. It could be shown from the expression for the orientation polarisation of such solutions, on certain assumptions, that μ the dipole moment of the ions must be proportional to $\sqrt{z}$, and not to z, as would be expected for a regularly increasing straight zig-zag chain length. Such a proportionality law is, however, in agreement with the statistical calculations of the shape of long chain hydrocarbon molecules carried out by Kuhn (*Koll. Z.*, 1934, **68**, 2). Kuhn has now extended these calculations for the actual case of amphoteric ions where there is an attraction between the oppositely charged ends (*Z. physikal chem.* (A), 1935, **175**, 1), and finds that while the value of r^2 the average of the square of the distance between the two ends is different, the proportionality law $r^2 \sim z$ remains unaffected. Incidentally it is found that the inner field must be weak in these solutions on account of the solvent molecules interposed between the ends of the chain.

M. A. G. RAU.

Formation of Molecular Clusters in Liquids.

WHEN light polarised in the vertical direction or Z-axis is incident on a medium, the light scattered at right angles is essentially a mixture of linearly polarised light and some natural light. This depolarisation is due, as is well known, to the occurrence of anisotropies along with density fluctuations in the volume element of the liquid medium. That the scattered light is a mixture of the natural with the linearly polarised light is also demonstrated by the fact that when the incident light is polarised along a horizontal or the Y-axis, the scattered light is pure natural light with equal polarisations along the X and Z axes. The depolarisation factor is 1. Recently R. S Krishnan has observed (*Proc. Ind. Acad. Sciences*) that when the last experiment is carried out on a liquid mixture which shows a critical solution temperature, then over a range of temperatures above this, the scattered light contains in addition to the natural light some linearly polarised light also. The depolarisation is thus <1. This phenomenon has been rightly attributed by him to the presence of large clusters of molecules in the medium. Prof. R. Gans has now analytically examined the shape and size of such clusters (*Physikal Zeit.*, 1936, **37**, 19) and shown that the clusters must be non-spherical in shape in order that, what he calls, the Krishnan effect, may be observed.

M. A. G. RAU.

The Structure of Hydrous Oxide Sols and Gels.

THE constitution of Sols and Gels in general and of the hydrous oxides in particular is a subject of a great deal of interest, though there is still difference of opinion amongst workers in this field. Weiser and Milligan have tackled this problem from various points of view in a recent paper (*Trans. Far. Soc.*, 1936, **37**, 358). Regarding the constitution of gels of ferric oxide, alumina and stannic acid, they have shown by Phase rule studies of the dehydration process as also by X-ray diffraction methods, that the gelatinous oxides are not polymerised bodies or products resulting from the loss of water from hypothetical metallic hydroxides. The view put forward by Willstätter and others that a part of the water in the gel is chemically combined and a part as being adsorbed has not been found to be tenable. The X-ray methods have revealed that during the ageing of the gel of ferric oxide, there is a gradual agglomeration of extremely minute

crystals of the oxide which hold large amounts of water by adsorption or capillary forces. In the case of alumina gels, there is evidence for the formation of a single hydrate, *i.e.*, γ Al_2O_3. H_2O. The constitution of the α and β stannic acids has also been settled by X-ray analysis, and it is found that the difference in their properties is due to the size and extent of the aggregates.

The structure of the micelle in hydrous oxide sols is also of considerable importance. The existence of basic salts of definite composition in sols has been seriously questioned. Pauli has suggested the formation of complex colloidal ions, while Thomas and his co-workers have formulated Weiner complexes in the micelle. These assumptions are rendered highly improbable by X-ray studies. Potentiometric analysis has also been employed for the study of the structure of interfaces in aqueous colloids. The micelle of the hydrous oxide sols are aggregates of crystals of the oxide with anions adsorbed on the surface. It has however been pointed out by K. H. Meyer that the term adsorption is referred only to the places where ions or molecules are held up, and not to the nature of the forces responsible for such linkages, which may be Dipole forces, electrostatic attraction or homopolar binding.

M. P. V.

Soy Bean Oil as Core Oil.

OIL bonded cores are much in evidence in America, where the sand used is rather coarse, necessitating the use of some bonding material such as commercial linseed oil, Japan drier and kerosene. The suitability of Soy Bean oil, by itself and when mixed with different proportions of linseed oil, Japan drier and kerosene, has been the subject of investigation at the Engineering Experiment Station of the University of Illinois in the department of Mechanical Engineering. The results have been published in the *University Bulletin* (*No.* 235, 29, No. 11, dated October 6, 1931), by Carl H. Casberg and Carl E. Schubert. Several kinds of Soy Bean oil were tested by the standard methods adopted by the American Foundrymen's Association. It was found that the tensile strength of cores tested bore a certain definite relation to the iodine numbers of Soy Bean oil and kerosene, the ratio being

$$\frac{\text{Tensile strength}}{\text{Iodine Number}} = 1{\cdot}0161.$$

Tensile tests were made on cores (1) with raw Soy Bean oil, (2) with Soy Bean oil and kerosene, (3) with raw Soy Bean oil, kerosene and Japan drier, (4) with raw Soy Bean oil and linseed oil, and (5) with raw Soy Bean oil, linseed oil and kerosene, made of core sand of A.F.A. specification class No. 4. In each case it was observed that the tensile strength was maximum when the cores were baked for not more than one hour, the percentage of raw Soy Bean oil to Japan drier being 85 : 15 for optimum conditions. The main conclusion arrived at was that raw Soy Bean oil was suitable as a core oil, provided that the cores were baked for required times (one hour in most cases) depending on the fact whether it was used by itself, or mixed with linseed oil or with different proportions of kerosene or kerosene and Japan drier.

K. B. K. R.

The Sugar Industry in India and the Borer Pest of Sugarcane.

IN a well-reasoned statement supported by facts and figures, Noel Deerr (*Agriculture and Live-Stock in India*, Vol. 5, Pt. III) draws attention to the serious menace of the sugarcane borer pest in Upper India and pleads for strong and prompt measures being taken to control the pest. As the result of a survey of typical areas he states that the crop in Upper India is heavily infested and that associated with the borer injury is also the loss of sugar in the cane due to the entry of micro-organisms into the cane through the door of the wound injury. Even in an exceptionally fine crop the loss to the grower is put down as 8 per cent. The average of eight surveys brings out the loss to the miller as 800 maunds of sugar per 100,000 maunds of cane crushed and that, if calculated for the industry in the whole of India, this works out to a loss of one crore and thirty-three and a half lakhs of rupees. To this is to be added the corresponding loss to the Excise revenue of the State which will amount to 12 lakhs of rupees annually. The same and perhaps more may be said of the sugarcane being grown for the factory in Mandya. A strong plea is put forward for starting control measures by means of the parasites of the cane borer which have been found about the only satisfactory method elsewhere and to the success of which in the Hawaii he bears

personal testimony. He would suggest the expenditure on such a campaign being met as a legitimate charge on the Sugar Excise revenue now being collected. In Mysore a beginning has already been made on this very method of biological control which, however, has to be carried on on a very much more extended scale than at present if it is to make any impression at all in arresting the pest.

A. K. Y.

The Burning of Forest Pastures.

THE reasons underlying the ancient practice of setting fire to hill side and forest grass land after the season's growth is over which, though strongly condemned from the point of view of forest conservation, is persisted in the belief that it improves the pasture value of the land, are examined in the course of an extended study of the matter and some very interesting and suggestive conclusions drawn by S. W. Greene of the U. S. A. Bureau of Animal Industry (*Journal of Agricultural Research*, **50**, 10). We can only extract parts of the summary of the conclusions and would commend a perusal of the full paper itself to interested readers as some of the data point to the need for a revision or at least a re-examination of current views on important aspects of agricultural practices.

Analyses of soils taken after 8 years of annual grass burning as compared with complete fire protection showed 1·6 times as much organic matter in the burned over soils as in the protected soils. The former also contained 1·5 times as much nitrogen as the protected soils. The greater quantities of organic matter and nitrogen apparently result from roots rather than from the above ground portions of the plants. Whether the plant debris was burned in place on top of the soil or was left to rot apparently had no direct effect on the content of organic matter or of nitrogen. In both cases organic matter and nitrogen above ground was largely lost to the soil, the increases thereof being influenced only by the amount and composition of decaying plant roots. Grass and legume growth on the areas showed that the forage growth on the burned areas was more than double that on the unburned areas after a period of 8-9 years of experiment. The increased amount of nitrogen in the burned areas is attributed to the increased growth of native legumes, their ability to take nitrogen from the air and the additional growth of other plants which take up soluble forms of nitrogen and prevent them from being leached out. The increase in organic matter and nitrogen on the burned areas was also reflected in the higher crude-protein content of the principal forage grasses on this area and in the increased number of soil micro-organisms. The accumulation of plant debris on the top of the soil did not materially increase the soil moisture in spite of the fact that much larger quantities of water were required to support the extra forage growth on the burned over areas. Organic matter on top of the soil absorbs a portion of the rainfall which is thus prevented from reaching the soil for the use of growing plants.

The experiment was conducted on a tract of 320 acres of virgin forest land in southern Mississipi, U. S. A.

A. K. Y.

Pyosepticæmia of Calves.

IN the Punjab from figures collected over a period of five years, cases of Pyosepticæmia of calves are noticed to occur commonly and in a serious form on certain farms periodically, affecting chiefly calves over 10 days and under four months old, about 35 per cent. of cases proving fatal (Shirlaw, *Indian J. Vet. Sci. and Animal Husb.*, 1935, **5**, 232). Adults also are seen affected sometimes. The disease is septicæmic in young animals and pulmonary of a special type in old animals. An organism of the *Salmonella enteritidis* group is stated to be the cause in the Punjab as it was discovered from a majority of the cases there. Specific agglutinins against this organism were observed in the sera of diseased calves and their mothers. Direct contact and feeding on cultures fail to transmit the disease to healthy calves. Subcutaneous and intravenous inoculation of cultures produce the disease in indigenous calves.

S. D. A.

Bovine Nasal Schistosomiasis.

THE length frequency curves of the ova of *S. nasalis* and *S. spindalis* provide additional proof that these two worms are different (Anantha Narayana Rao, *Indian J. Vet. Sci. and Anim. Husb.*, 1935, **5**, 266). No abnormal shapes of ova of *S. nasalis* could be detected in mature ova examined. The previous experiments of artificial infestation

with *Cercariæ indicæ* XXX Sweell, 1922, to produce nasal schistosomiasis are confirmed. The buffalo and some bovines appear to have a partial immunity conferred by *S. spindalis* against a later infestation with *S. nasalis*. The presence of what looked like ova of *S. nasalis* in a growth from the base of horn of a bullock is recorded. Susceptibility of sheep to nasal schistosomiasis appears to be doubtful.

Spermatogenesis of Stenophylax.

A BRIEF account of Stenophylax spermatogenesis has been given by R. A. R. Gresson (*Quart. Journ. Micro. Sci.*, Vol. 78, No. 310, Dec. 1935). The nucleus of the spermatocyte is seen not to take any important part in the formation of the chromosomes and persists as a distinct body till the end of prophase when it is probably cast out. The diploid chromosome number is sixty. The Golgi material which is at first in the form of a single mass divides into two parts just before division, which become distributed between the two daughter cells. The mitochondria are granular and during division arrange themselves on the sides of the spindle and so get distributed between the daughter cells. The Golgi body is probably responsible for the acrosome but the main part of the former becomes fragmented and enters the tail of the sperm. The mitochondria are filamentous in the spermatid and invest the axial filament in the form of a close sheath. A peculiar clear vesicle is seen to arise in the spermatid nucleus: its significance is unknown and it disappears later.

The Vascular System of *Octochætus thomasi*.

A DETAILED account of the vascular system of any acanthodriline earthworm is not described anywhere and therefore M. Bleakly's paper on *O. thomasi* (*Quart. Journ. Micr. Sci.*, 1935, **78**, Part II), is of considerable interest. The dorsal vessel is double posteriorly to the gizzard, being connected with each other by commissural vessels anterior to each septum. There are six pairs of lateral hearts occupying segments 8 to 13. The dorsal vessel supplies blood to the lateral hearts and also to the ventral vessel. The latter is the main arterial trunk and the flow of blood is backward posterior to the hearts. The dorso-intestinals and dorsotegumentaries debouch their blood into the contractile dorsal vessel. The dorsal vessel is arterial in nature anterior to the hearts while posteriorly it is venous. No subneural vessel is present.

Radioactivity and Geothermal Gradients.

IN a paper read before the Royal Society of Canada, Justin De Lury and H. C. Lane (*Pan-American Geologist*, **64**, No. 2) have shown the intimate relation that exists between radioactivity and thermal gradients. From the data compiled by different workers, it is believed that granite is two to three times richer in radioactive elements than basalt, and four to five times richer than peridotite. The radioactive elements are largely concentrated on the surface and their distribution is by no means uniform. These radioactive elements are considered to be the important source of heat, specially at shallow depths. The observed variations in thermal gradient are due to the varying distribution and concentration of the radioactive elements. According to the authors the important factor governing the thermal history of the Earth, is the migration of the radioactively rich materials "both horizontally and vertically" due to the erosion and movements of the magma.

Schiller Structure.

SINCE the time of Werner, the word "Schiller" has been used to express a particular type of sheen structure noticed in minerals. But later some authors have extended the term to include the iridescence noticed even in certain of the felspars, amphiboles and pyroxenes. In reviewing the usage of the term "Schillerisation" in Geological terminology R. J. Colony (*American Mineralogist*, **20**, No. 12) has shown that the term schiller structure is a misnomer, because there is no single specific structure responsible for the effect, since it is dependent not upon the kind of the inclusion but upon its size and thinness. Hence a suggestion is made by the author that the term schiller be restricted to iridescence displayed by minerals where the "sheen is caused by reflection of the light from either inclusions or planes". For all other types of minute inclusions the author suggests the use of the term "Endoblastic".

Nappe Structure in the Archæan Rocks.

FROM an intensive study of the structure shown by the Archæan rocks around Deolapar, in the Ramtek tahsil of the

Nagpur District (forming part of the well-known Sausar series of Dr. Fermor) Mr. W. D. West (*Trans. Nat. Inst. Sci., India*, I. No. 6, pp. 93-102) has put forward some evidence to show that in this area, the folding of the rocks reached the highest degree possible, and that a large body of rock, covering many square miles, was forced horizontally over a considerable distance, the *Nappe* thus produced coming to rest discordantly upon another portion of the same series of rocks. After giving a detailed account of the geology of this area, Mr. West has followed two main lines of argument, in support of his inferring a *Nappe* structure. One argument is based on the fact that a definite plane of discordance in the succession of rocks has been determined of such a nature as to suggest horizontal rather than vertical movement. The other argument is based on the sudden change in the lithology of the Bichua stage, so strikingly seen just east of Deolapar, which suggests that the two outcrops of the Bichua stage found here were not originally deposited as close together as they are now found.

While it is true that the evidence for a *Nappe* structure in this area is not by any means indisputable, it is obviously difficult to offer any other explanation of the facts mentioned in the paper; and though the conclusion reached by Mr. West has been based on the study of a comparatively small area, there is no doubt that the recognition of the existence of the *Nappe* structure in the Archæan rocks, involving the horizontal displacement of large rock masses, will help to explain some of the metamorphic anomalies and difficulties of correlation which are so puzzling in these very ancient rocks.

Attrition Tests on Stone used as Road Metal in India.

DR. M. S. KRISHNAN in an interesting paper (*Rec. Geol. Sur. India*, 1935, **69**, Pt. 3, 361–383), has given an account of the tests on road-making stones carried on for about a decade past in the Engineering section of the Government Test House at Alipore, Calcutta. After outlining briefly the method of experimentation, the results of tests carried on a very large number of samples covering a variety of Indian rocks, have been arranged suitably in tabular form. A discussion of the test results has also been included and Dr. Krishnan states, "the best stones for road-making purposes are the medium to fine-grained, compact, basic rocks like dolerite, basalts and epidiorites. The coarser grained rocks, acid types and compact gneisses come next. Granulites and hornfelses also occupy a high place amidst road-stones. The markedly porphyritic rocks are liable to be crushed under load. The soft rocks like the limestones, shales, laterites and the weaker types of sandstones are not suitable for any but light traffic, while vein quartz and quartzite (except perhaps some highly ferruginous types) are generally to be avoided."

M. B. R.

Industrial Outlook.

Modern Sewage Pumping*: The Latest Scientific Principles.

DURING recent years great advances have been made in the pumping of sewage and a good example is the extensive additions and alterations that have recently been carried out in England at the Reading Corporation sewage works, Manor Farm (Berks).

In general the additions comprise two new concrete pre-sedimentation tanks, each 160′ 0″ × 52′ 6″ with a depth of 8′ 0″, together with all the necessary mains and connections. Also there are three new pump houses, nine new sludge drying beds having a total area of about five acres, six large solid digestion tanks with a total capacity of over 3,000,000 gallons, new filters with an area of approximately two acres, and a depth of 10′ 0″, and six new concrete humus tanks each 100′ 0″ × 50′ 0″.

Much other accessory plant and equipment is included, as well as two 24″ diameter concrete mains having a total length of about two-thirds of a mile, which connect the filters to the main works. Operations were commenced in May 1934 and the scheme has now just been completed.

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* Contributed by David Brownlie, 46, Grange Road, Ealing, London, W. 5.

The pumping plant is being supplied by the Pulsometer Engineering Co., Ltd., Reading, and the full equipment, operating in the three pump houses, includes six "Stereophagus" pumps and one "A. V. 4." and one "F.W.4. (Fullway)" centrifugal pump, all direct driven by slip ring A/C motors (3-phase, 50 cycles, 220 volts). Two of the "Stereophagus" pumps are 5″ diameter with horizontal drive, each with a capacity of 475 gallons per minute of unscreened sewage, while another of the pumps, 5″ diameter with horizontal drive, has a duty of 300 gallons of crude sludge per minute.

Also two of the "Stereophagus" pumps are of the vertical drive type, one being a 6″ unit with a duty of 550/650 gallons per minute for the main sludge, and the other 4″ diameter, operating the sludge return with a duty of 200 gallons per minute. Finally there is a 4″ horizontal pump of this type with a duty of 260 gallons per minute of effluent. As regards the "A.V." 4″ centrifugal pump this also has a horizontal drive and takes the top water and the humus, with a duty of 317 gallons per minute.

Essentially the "Stereophagus", it will be remembered, is a modified form of centrifugal pump with a conical impeller and a special internal cutting knife of hardened steel so that it can deal with unscreened sewage cutting up the solid matter in suspension to a size which facilitates subsequent handling. The impeller revolves in a volute casing and in normal running the liquid is passed by the impeller alone and the knife which is fixed parallel to the face of the impeller vanes, does not come into action until some solid material enters which is too large to pass between the vanes. When this happens it is immediately cut by the scissor-like action given by the stationary knife and the moving plates, the solid passing the knife again and again until sufficiently small to pass through.

Further with regard to the Reading Corporation it may be stated that two "Stereophagus" installations of this kind are already operating, one at the Whitely Road pumping station, consisting of two 5″ horizontal spindle pumps, each of 355/465 gallons per minute capacity, and the other at the Kidmore End pumping station, which has two 3″ vertical spindle pumps, each of 100 gallons per minute capacity.

Carbon Dioxide for Fire Fighting.*

Latest Designs in Portable Equipment.

A VALUABLE method of fire protection at electricity stations and industrial establishments now being more and more employed is the use of a permanently installed battery of high pressure cylinders filled with liquid carbon dioxide, situated in some central position, and connected up by narrow bore pipe in the danger points. By opening valves automatically or by hand on a control panel a vast volume of carbon dioxide gas can be poured into the flames, which are thereby smothered immediately because of the dilution of the oxygen of the air below the limit necessary for combustion. Thus an atmosphere containing only about 17 per cent. carbon dioxide will extinguish a fire, and this method is of great value for dangerous fires such as resulting from petrol, benzol, oil, turpentine, paint, varnish and tar.

Well-known specialists in this field of fire fighting by carbon dioxide gas are Foamite Firefoam Ltd., of London (55–57, Great Marlborough Street, W.1.) and considerable interest attaches to the latest designs of their "Alfite" portable equipment which operates on the same principle as the permanent plant, and is suitable for a wide range of conditions. For example, the small hand machine, easily carried by one person, consists of a cylinder containing 7 lbs. weight of liquid carbon dioxide, corresponding to about 60 cubic feet of gas. Included is a short flexible pipe and a wide "spray" head for directing the gas upon the flames, whilst the top of the cylinder has a small valve which on operating allows the gas to escape with great force in the form of a stream.

A larger size containing 12 lbs. of liquid carbon dioxide gas is also available, while another standard "Alfite" portable equipment consists of a large cylinder containing 50 lbs. of liquid gas, fixed in a horizontal position, on two wheels, propelled however to the scene of the fire and operated by one person.

The total weight of the machine is 380 lbs. and 12 feet of flexible hose is provided for directing the 450 cubic feet of gas represented by the above amount of liquid.

It will be remembered that a number of different methods are available for fire fighting

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* Contributed by David Brownlie, 46, Grange Road, Ealing, London, W. 5.

including water, acid-alkali extinguishers, carbon dioxide gas from cylinders, foam, and inert heavy vapours, such as carbon tetrachloride. Two separate principles are concerned, cooling the material to below the temperature necessary for combustion (combination with the oxygen of the air) or diluting the oxygen to the point when it will not support active combustion. As already stated, carbon dioxide acts in this way, and the same applies to carbon tetrachloride, used for motor car extinguishers, whilst water depends almost entirely on the first principle, reducing the local temperature. The firm make equipment using all the above methods, and foam for example, extremely valuable for many conditions, consists of a close aggregation of bubbles formed of a resistant film or skin filled with carbon dioxide gas made by mixing a special alkaline and acid solution. What is the best method to adopt depends upon the exact circumstances, and efficient fire fighting to-day is of course a highly complicated business using a great assortment of fast motor vehicles and rescue apparatus of different types.

Science in the Service of Indian Agriculture.*

THE material results of scientific discoveries have, as elsewhere in the world, greatly benefited rural India and her agriculture. Better transport, better illumination, the rural electric supply, the telegraph and the wireless are all tending to raise the standard of comfort in the villages. An even greater service is the application of the scientific method in the solution of the problems of agriculture which is largely an art and perhaps primarily a business. The conscious application of the scientific method is barely a century old but an immense amount of agricultural lore, gained as the result of experience, has accumulated which is both important and deserves to be scientifically interpreted. In India, the first attempts at improving agriculture took the form of the opening of model farms for copying the methods in vogue in advanced countries. The appointment of American cotton growing experts, the importing of agricultural machinery including steam ploughs and the opening of model farms in Madras, Bengal and the U. P. belong to this phase. The next landmark is the report of the Famine Commission of 1880 and its successor of 1901 to which we owe not only the development of irrigation, communications, rural credit, etc., but also what eventually became the Provincial Departments of Agriculture. The visit of Dr. Voelcker and his most valuable report followed, as likewise successively the appointment of individual experts like Mr. Mollison, Dr. Leather, Dr. Barber and Dr. Butler. In 1904 Lord Curzon's Government made the next great advance which resulted in the creation of the Imperial Department of Agriculture, the opening of the Pusa Research Institute and the starting of properly equipped scientific Departments of Agriculture in the Provinces. Steady progress has followed and thanks to the wise and far-reaching recommendations of the Royal Commission on Agriculture research can now be organised and financed with a precision previously unknown. With the Universities and kindred institutions co-operating with the Agricultural departments the stage has now been set for a great advance in rural uplift.

With this somewhat familiar historical background we may now describe the contributions of the different sciences to the improvement of Indian agriculture using the term however in its narrower sense of mere crop production. This improvement in crop production has been along three directions, *viz.*, the improvement of the plant, its better nutrition and better protection against pests and diseases. More progress has been made in plant improvement than in improved plant nutrition in India for reasons partly economic and partly technical. The rapid advance in the science of genetics and its application to plant breeding has naturally led to much attention being paid to the improvement of the staple crops of the country. As a result, the area under improved wheats alone is well over 16 million acres, to take the case a most important crop. Wheat indeed was one of the first crops to be studied the names of the Howards, of Milne and of Evans being associated with this important work. The varieties originated are all of high merit, one of them Pusa 12 having given double the yield of the local, over a seven-year period of trial. All are also of high milling value and Pusa 12 combines with high yield, earliness, hardiness and good milling and baking quality. The Pusa improved tobacco is a cross between the Adcock and the Pusa 28 and combines the excellence for cigarette making with the valuable agricultural features of the local parent; the improved linseed of Pusa combines the root system and the agricultural habit of one type with the high oil content of another; and the types of *Cajanus indicus* evolved in Pusa are largely resistant to the wilt disease.

The work on sugarcane improvement at the Coimbatore Research Station has resulted in the production of highly satisfactory crosses between the wild cane and the noble or tropical cane, eminently suitable for cultivation in Northern India where they now occupy some 60% of the total cane area of India. In the improvement of the cotton crop, tests for the spinning quality of the various strains evolved by plant breeders are systematically carried out at the Cotton Technological Laboratory of the Indian Central Committee, so that improved cottons undergo a rigid test on this important requirement of quality before they are pronounced as really

* Summary of a lecture delivered by Sir Boyce C. Burt, at the Twenty-third Annual Meeting of the Indian Science Congress, Indore, 1936, on 3rd January.

improved strains. In this particular aspect of cotton improvement work, India can be said to be ahead of other cotton growing countries and our Technological Laboratory is in many ways a unique institution. The result of all this work on cotton improvement is that quite 4 million acres are now under these improved varieties and that but for this development India will be importing foreign cotton to the value of some 7 crores of rupees.

In respect of better plant nutrition the second line of improvement work has somewhat lagged behind. Numerous experiments have brought out however the great deficiency of nitrogen in Indian soils, the need for organic manures, of aeration and of drainage. All of these have been emphasised and composts and green manures studied and recommended. Work on soil colloids, on the laterite soils of Eastern Bengal, on rice and sugarcane soils in the Bombay Deccan and the C. P. is in progress as well as a comprehensive scheme for the study of dry-farming methods. Problems of excess water, of waterlogging, alkali troubles and kindred matters relating to irrigation are also receiving attention. In regard to artificial manures they have been found to be economic under certain circumstances and India now uses not only the whole of her local production of 13,000 tons of ammonium sulphate, but also had a net import of 38,000 tons in the year 1931–35. Field experiments covering manurial and other problems have become more precise in lay-out and interpretation, thanks to the aid of mathematical technique furnished by the Research Council.

The third division in crop improvement relates to the avoidance or reduction of losses caused by plant pests and diseases. These levy a heavy toll on agricultural wealth and there is need for all the help science can give. Taking sugarcane for instance, these pests comprise moth borers, the Hispa beetle, the cane hopper, mealy bugs, white fly and termites. By suitable varieties, cultivation methods and dusting with insecticides some of these can be controlled and biological methods also hold out promise. The pink boll-worm of cotton and the spotted boll-worm cause large losses annually, but simple methods of control have been devised and demonstrated, *viz.*, the heating of the seed in the first case and the removal of the cotton stumps after harvest in the second case. The heating of the seed has been found to impair neither the vitality nor the oil content of the seed.

Plant diseases are caused by fungi, bacteria or viruses and the best weapon to fight them with in India is the use of immune or resistant varieties, coupled with proper cultivation and rotation methods. Direct methods are also economic, and good instances of such work are furnished by Mysore where spraying arecanuts to prevent the nuts dropping and the coffee bush to prevent leaf disease is extensively practised.

Among improved implements, mention may be made of the large number of improved ploughs being sold annually and of that most recent introduction, the pneumatic tyre for bullock carts. The latter has been found to result in 50% increase in the hauling capacity, in less strain and jerking and fewer sore necks.

The scientific worker in India will find a wealth of material for research in agricultural problems intricate enough for the most ambitious. In all applied sciences, the most important problems often lie on the border line of two or more pure sciences and their successful solution leads to an advance in general knowledge or to the opening up of new fields of scientific investigation. [The address was profusely illustrated by a splendid set of lantern slides.]

Preparation of Fine Chemicals in India.

A SYMPOSIUM on the scope of preparation of fine chemicals in India was held at a meeting of the Chemistry Section of the Indian Science Congress 1936, under the Chairmanship of Dr. P. C. Guha, the President of the Section.

In opening the discussion, Dr. P. C. Guha stressed the desirability of considering seriously the question of preparing fine chemicals in India. A start has been made by the Organic Chemistry Department, Indian Institute of Science, Bangalore, where, since the inception of the Preparation Section in 1930, more than 200 research chemicals have been prepared (some of them in considerable quantities) in an economic way. When an experimental scheme of this nature has to be viewed on a commercial basis, several points demand careful consideration. Now that the preliminary efforts have proved successful, the time has arrived when Indian capitalists should make an attempt at commercialisation. The history of the Eastman Kodak Company of Rochester may be recalled in this connection, and this should serve as a stimulus. India possesses several advantages; for instance plenty of cheap expert and ordinary labour is available. A beginning can be made with the object of meeting the demands of the laboratories. Such an establishment with its *indispensable research section*, could undertake the preparation of other chemicals of general and every-day use in industries and also exploit the possibility of utilising the chemical resources of India. Caution is necessary in such an enterprise and external source of information and experience cannot be depended upon and the necessary technical skill being acquired by Indians themselves. India, like other advanced countries, must pass through a preliminary evolutionary period, but this instead of damping her spirit should make her all the more resolute and active. Prof. Guha appealed to capitalists to utilise the experience already available in the country and explore the possibility of starting industries in this line.

Dr. Wheeler (Bombay) endorsed the President's views and added that some firms in India should take the lead. He felt that the Council of the Indian Chemical Society might organise the production of a limited number of important research chemicals in the various university chemical laboratories. Dr. J. C. Ghosh (Dacca) supporting, instanced the case of a pupil of his, successfully starting the manufacture of gas mantles at Dacca. Dr. N. R. Dhar (Allahabad) felt certain that there is plenty of scope for the

manufacture of fine chemicals in India. He observed that there is no dearth of well-trained chemists in the country, but what is lacking is business experience which is of great importance in running a manufacturing concern. He cited an instance of a properly trained chemist earning Rs. 150 per month by purifying (by recrystallisation) ordinary bazaar chemicals and selling them to the schools and colleges in the United Provinces. Dr. R. B. Forster (Bombay) observed that before the preparation of chemicals could be undertaken, it was essential to have the necessary supply of starting materials and solvents. There is no reason why the distillation of tar should not be undertaken and the importation of raw materials rendered unnecessary. Dr. N. N. Godbole (Benares) opined that fine chemicals can and should be manufactured in India. While pointing out the difficulties in packing and selling, the latter requiring business experience, he suggested the desirability of the Science Congress constituting a body that will analyse and certify the standard preparations. Dr. J. N. Ray (Lahore) was in full sympathy with the views expressed by the President and Dr. Wheeler. He realised that such ventures may not be financially very profitable in the beginning but if the Indian Chemical Society takes the lead, there is no reason why the desired goal should not be achieved. While expressing his disagreement with the view expressed by Dr. Forster, *viz.*, that it is essential to manufacture starting materials and solvents, pointed out the possibilities of exploring new solvents, *e.g.*, furfurol, furyl alcohol, etc., there is no reason why alkaloids, *e.g.*, ephedrine, emetine, etc., as also other useful chemicals from indigenous plants could not be economically manufactured in this country. Dr. J. N. Mukherjee (Calcutta) expressed the view that as a first step, it is desirable to restrict the scope to the preparation of such chemicals as would meet the requirements of research workers in India. By mutual agreement a list might be prepared and the work may be distributed over the different laboratories. Regarding the broader issue of preparations on a commercial scale, he suggested that the first step should consist in collecting information on the possibilities and to have them critically examined by a committee with a view to arriving at definite proposals.

The following resolution proposed by Dr. N. R. Dhar and seconded by Dr. J. N. Ray was unanimously passed at the meeting :—

> "That the Council of the Indian Chemical Society be requested to carefully consider this important question and explore means as to how and on what lines the preparation of fine chemicals can be undertaken in this country."*

* The following resolution was passed at the annual general meeting of the Indian Chemical Society held on Monday, 6th January, at Indore :

"Resolved that a committee consisting of the following members with powers to co-opt be appointed to consider possibilities of preparing fine chemicals for laboratory use and to collect informations regarding the possibility of new chemical industries in India :

Dr. H. K. Sen (Calcutta) ; Dr. J. N. Mukherjee (Calcutta) ; Dr. S. K. Ray (Dhanbad) ; Dr. P. K. Ghosh (Calcutta) ; Dr. N. N. Godbole (Benares) ; Dr. J. K. Chowdhary (Dacca) ; Dr. N. R. Dhar (Allahabad) ; Dr. P. C. Guha (Bangalore) ; Dr. P. C. Mitter (Convener) ; Dr. T. S. Wheeler (Bombay) ; Dr. S. G. Sastry (Mysore) ; Dr. B. Sanjiva Rao (Bangalore) ; Dr. K. L. Moudgil (Trivandrum) ; Dr. S. S. Bhatnagar (Lahore) ; Dr. M. S. Patel (Bombay) ; Dr. K. H. Hassan (Hyderabad, Deccan) ; Dr. B. S. Srikantan (Waltair) ; Dr. N. G. Chatterjee (Cawnpore)."

Progress of Fuel Research.*

THE Department of Scientific and Industrial Research issued the Report of the Fuel Research Board together with the Report by the Director of Fuel Research for the year ended 31st March 1935. The Report is made the occasion for a review of the progress achieved in the Fuel Industry during the twenty-five years of His Majesty's reign. Consideration is given to the relation between the Board's researches and the remarkable changes which are taking place in the utilization of coal.

Despite increasing industrial prosperity and rising population the consumption of coal in Great Britain has fallen from 180 million tons a year in 1910 to 165 million tons in 1934. It is sometimes suggested that this fall is due to the replacement of coal by oil but the report shows that this is largely erroneous and the decrease is due mainly to the increased efficiency of practically every process for which coal is used.

In 1910 about 4½ million tons of coal were required to produce 2,500 million units of electricity, while for the 16,100 million units generated by authorised undertakings in 1934 only 11.4 million tons were necessary. If the efficiency of production of electrical power had remained the same, 29 million tons of coal would have been used in 1934.

An overall thermal efficiency exceeding 27 per cent. has now been obtained in large installations and further major advances in this direction cannot be expected. Incidentally it may be stated that the capacity of individual boilers has been raised from 20,000 or 30,000 to 300,000 pounds of steam per hour, and an efficiency exceeding 90 per cent. has been attained in this section of the plant.

The gas industry has also made great advances, and in the period under review the gas supplied by all authorised gas undertakings in Great Britain increased from 178,000 million cubic feet in 1910

* Department of Scientific and Industrial Research; Report of the Fuel Research Board for the year ended 31st March 1935, with report of the Director of Fuel Research. His Majesty's Stationery Office, London, xi + 188 pp. Price 3 *sh.* 6*d.* net.

to 295,300 million in 1934, while in the same period the coal used only increased from 15.1 to 17.1 million tons a year. If the efficiency of the process of gas manufacture had remained stationary throughout the period an additional 7.9 million tons of coal would have been needed by the industry in 1934. Coke ovens now supply 18,000 million cubic feet per annum to the gas industry. This closer co-operation between the two sections of the carbonising industry emphasises the need for an examination of the types of coal-blends suitable for coke and gas manufacture, a question that is being investigated at the Fuel Research Station.

The coke-oven industry is closely associated with the iron and steel industries, whose coal requirements have fallen by some 15 million tons a year. A considerable proportion of this is due to reduction in the amount of pig iron produced, but it is claimed by the British Iron and Steel Federation that since 1923, largely from the application of the results of research, £1,500,000 per annum has been saved in the cost of fuel. This figure indicates broadly that about 6 million tons less coal were necessary in 1934 than would otherwise have been the case.

The economies in the use of coal in furnaces have been secured largely by burning it in a form that enables it to be fed at a controlled rate into the combustion space. The greatly increased use of mechanical stokers and of pulverised fuel has given to coal and coke a large measure of the flexibility possessed by fluids such as oil and gas. Quite substantial advances are taking place at present in applying mechanical stokers to comparatively small coal—or coke-burning units such as are installed for central heating.

The use of pulverised fuel has increased in the last five years from 2¾ million tons per annum to over 4½ million tons. The Pulverised Fuel report states :—

> "Pulverised fuel is used for many purposes and there has lately been a marked expansion in its application to metallurgical purposes, which include heating and reheating billets, smelting and melting, annealing and copper refining. It is of interest to record that at the end of 1933 the first plant for supplying coal ready-pulverised was installed by a colliery in Yorkshire, and that pulverised coal of a standardised calorific value is now being offered from a plant in the London area for delivery in tank wagons to small consumers.
>
> "Though these economies have the immediate result that less coal is mined, the total energy derived from coal and usefully applied was appreciably greater in 1934 than in 1910. The gain in efficiency has an important bearing on the cost of living and the cost of production of manufactured articles."

In the last eight years the amount of coal cleaned has risen from 51.4 million tons or 20 per cent. of the total coal raised to 87.5 million tons a year or 40 per cent. of the total.

The notable advances that have been made in cleaning coal, both by wet and by dry processes, have resulted in a reduction in the amount of inert material that is transported from the collieries and handled, as clinker and ash, after the coal has been burnt; at the same time they have increased the difficulties of disposing of the dirt at the collieries.

Future improvements leading to increased economy in the use of fuel, the Report states, will depend more and more on the selection of the most suitable coal for the particular purpose required, and pre-treatment of the coal before its final combustion will become of increasing importance. The pre-treatment starts at the collieries, where the coal is graded and cleaned as required. The grading may consist of sizing alone, or may include blending the coal from different seams or the separation of the coal from one seam into different portions such as "hards" and "brights". Further pre-treatment consists in converting coal into gas, coke and tar, or its energy may be converted into electricity. The tar, or the coal itself, may be converted into motor spirit or oils.

The programme of research carried out by the Board is related to a greater or lesser extent to all these developments. Good progress is reported in the National Coal Survey which must form the foundation of future development in the use of coal. This work is being carried out in nine laboratories situated in the principal coal fields, and large-scale investigations are carried out at the Fuel Research Station. The object of the Survey is the examination of the coal seams as they occur in the ground and the various grades of coal as they are prepared and marketed by the different collieries.

> "There is an ever increasing movement," Dr. F. S. Sinnatt, the Director of Fuel Research, writes, "to regard coal as raised from the mine as a raw material which must be processed before it is offered for sale. In some respects coal is being viewed in the same manner as raw cotton. Treatment in washing and cleaning plants, screening into suitable sizes, together with the selection of parts of seams or the mixing of two or more seams, are the normal practice of the coal industry. This technique is, however, being rapidly refined, and accurate grading and precise mixing and blending to produce coals of uniform qualities are assuming increased importance. In some cases it would be an advantage if the inorganic matter present in the coal could be reduced to the lowest possible percentage: an extreme case would be the use of pulverised coal in internal combustion engines, should this develop, and there are signs that a demand may arise for "ultra clean" coal. Coal containing less than 2 per cent. of ash may be considered as ultra clean, but lower percentages are possible, and greater demands for coal of this type may be made in the future.'

In this connection, it is pointed out, that the results of the Survey are showing that in practically all the British coal-fields there are seams containing less than 2 per cent. of ash. In many cases a still higher degree of cleanness can be attained. In Durham, for example, the ash content of "brights" from the Plessey seam varies from 0.8 to 2.0. In South Yorkshire, Haigh Moor coal supplied for household purposes contained only 0.8 to 1.2 ash. In South Yorkshire some crushed samples indicated a yield of between 90 and 79 per cent. of coal containing

between 0.5 and 0.8 per cent. ash, and in South Wales two commercial samples were found to contain 0.7 to 0.8 per cent. ash respectively.

In other directions the work of the Survey is assisting in the often difficult problem of identifying coal seams, in districts where, for example, the seam is known by different names or different seams are known by the same name, or where correlation is difficult because of geological "faults". This problem, the Report states, is of importance because a wrong correlation of a seam may, after working through a disturbed area, result in unexpected troubles and danger from water and gas as well as in a waste of effort in searching for seams at a wrong level.

In North Staffordshire survey samples have been taken in a number of cases from seams which are not at present worked. In one case the results proved the seam to be of so good a quality as to justify the immediate re-opening of the mine. In South Wales and in the case of the Busty seam of Northumberland and Durham maps have been drawn showing where coal of various volatile contents occurs, thus enabling any variation in the coal to be predicted as the mines are developed.

Another interesting example of the work of the Survey comes from the Forest of Dean. Here it has been shown that a band of "black dirt" of variable thickness overlying the Coleford High Delf increases not only the amount of ash but also the sulphur in commercial grades, besides having a very deleterious effect on the coal from a carbonisation point of view. This material is similar in appearance and density to the coal itself and therefore does not lend itself to separation by any of the normal methods. It is concluded, therefore, that at present the only satisfactory method of dealing with this problem is to remove the "black dirt" from over the seam before actually getting the coal.

In connection with the preparation of coal for the market, good progress has been made at the Fuel Research Station with the development of methods of cleaning of fine coal and the clarification of washery water, leading to economy in the use of water and the prevention of river pollution. A new dry cleaning process is also being developed in which the unwanted dirt is separated from the coal by jets of air. Problems in connection with the mechanical breaking down of large coal to graded sizes suitable for particular purposes are being investigated.

In connection with the production of motor spirit and lubricating oil from home sources, researches have been continued into the principles underlying the hydrogenation of coal and the hydrogenation-cracking of tars and tar oils, the development of these processes is being studied in technical scale plant in order to obtain sufficient of the motor spirit and oils to test them under practical conditions. The motor spirit is being examined under service conditions. The most important item in this field has been the design and erection of a plant capable of treating about 300 gallons of tar per day, together with the distillation and refining plant required to deal with the spirit produced. Diagrams and descriptions of the plant are given, as well as an account of preliminary experiments to test the various parts and to gain experience in the control of the plant. The results of these experiments, it is stated, have fully justified the erection of the plant; only very minor alterations have been necessary, and little difficulty is anticipated in settling down to normal working at full capacity. It has been found that the technique of hydrogenation does not necessarily require high pressures and thanks to increasing knowledge of catalysts (*i.e.*, substances which hasten the chemical reactions although themselves remaining unchanged at the end of the process) a process has been worked out on a semi-commercial scale at the Fuel Research Station for treating, at atmospheric pressure, acids present in coal-tar from gas works and coke ovens to obtain motor spirits such as benzine.

Considerable progress has been made in the improvement of burners for pulverised fuel furnaces towards overcoming the difficulties of burning low volatile coal, such as some South Wales coal in furnaces, with restricted combustion spaces. Two of these new burners are being manufactured by commercial firms under licence and with one of them—the "Grid" burner—good results have been obtained in a Lancashire burner with a coal containing as little as 15 per cent. of volatile matter. A satisfactory solution has also been obtained to another practical problem presented in the burning of pulverised fuel. In pulverised fuel firing the distribution of the coal particles moving along a pipe or conduit in a stream of air is not uniform as regards the concentration or the size of the particles, so that dividing the stream into equal parts to supply two or more burners from a common stream is extremely difficult. Moreover, fluctuations occur—for reasons that are not fully understood—in the distribution, necessitating frequent adjustment of the burners to a varying supply of coal and air. A study has been made of the problems involved, and the difficulties have been overcome by a device that is at once simple and efficient. It appears, also, that the device can be adapted to other purposes; with slight modification it can be used for sampling, where a small proportion of material must accurately represent the bulk; or, on the other hand, the flow of material can be reversed, and the device will then intimately mix the material fed to it from separate streams. In some commercial installations, where they have been tried, these distributors have led to a reduction in the number of boilers necessary to supply the required load and to considerable saving in labour and fuel through the better reductions in fuel and labour costs through the better control made possible by their use.

The carbonisation of coal is being studied on a works scale in three types of retort—*viz.*, in a setting of horizontal retorts, in narrow vertical brick retorts, and in chamber ovens. Considerable interest attaches to a modified method of operating horizontal retorts, which has been developed at the Fuel Research Station. It has long been the practice to introduce steam into vertical retorts during carbonisation, but certain practical difficulties prevented this being done in horizontal retorts. The Report states that a successful method has now been evolved at the Station and the results show that the output of gas can be increased 8 to 10 therms per ton of coal carbonised, *i.e.*, the thermal yield of gas produced can be increased by about 10 per cent. at very slight extra cost. As nearly

7,000,000 tons of coal a year, *i.e.*, half the coal used in gas works in this country, is carbonised in horizontal retorts the potential value of this work to the gas industry is very great. Several large gas companies have been quick to realise this and have adopted the modification in their works.

"The intermittent vertical ovens," the Report states, "are in use for investigating the effects of blending strongly and weakly coking coals, with and without the addition of coke breeze. The best coking coals have been worked for many years, and in some districts are becoming scarce; it is therefore necessary to know as accurately as possible how good coke can be obtained from coals, or blends, not previously considered as possessing the best coking qualities."

Referring to domestic heating the Report states:—

"The open domestic fire is still a national institution, but is responsible for much direct and indirect waste of fuel, as well as for most of the costly smoke nuisance. Small inefficient industrial boilers also give rise to smoke and waste. The increasing use of gas, coke and electricity is steadily improving the position, and further developments in production of easily-combustible coke and of suitably-designed open grates will accelerate the improvement. The output of free-burning smokeless fuel, produced by carbonising coal at temperatures lower than those of coke-oven or gas-works practice, is gradually increasing. The amount of smoke, especially from small industrial furnaces, can also be reduced by using mechanical stokers and suitable blends of coal, which are now being prepared commercially."

"The optical method devised for the comparison of the densities of smoke emitted by different coals has been utilised to study the effect of coal blending on smoke reduction. The method consists in comparing the density of a column of the smoke passing through an inclined tube situated at the top of the chimney with smoke screens of known density. Preliminary experiments in well and bar grates have shown that the amount of smoke per lb. of bituminous coal can be reduced by 10–25 per cent. by mixing with a low volatile coal."

There are 36 figures which appear in appropriate places and render the explanations very easy to follow.

This is one of the very few technical publications we have seen, which, in our opinion, could be read even by the non-technical man with pleasure and considerable profit.

Recent Developments in the Chemistry of Bicyclic Terpenes.*

THE introductory portion of the address deals in a short but comprehensive way with the homocyclic "bicyclic ring-systems, in general". By means of a chart, an idea is given of the various bicyclic ring-systems which can be constructed with or without bridge members, starting from three, four, five and six membered monocyclic rings, and this is followed by a systematic discussion on the chemistry of the more important members of those of the individual bicyclic rings known to the day, thus bringing into prominence the gaps that remain yet to be filled. The theoretical speculations of Sachse and Mohr on the multiplanar character of *cyclo*hexane and higher carbon rings that led the way to the brilliant investigations of Huckel and his followers to a study of the stereochemistry of bicyclic rings like decalin and hydrindane are briefly referred to. In passing, the interesting case of *cyclo*hexane itself is examined. After shifting the evidence for and against a multiplanar configuration for *cyclo*hexane, the conclusion is drawn that any claim advocating the existence of multiplanar *cyclo*hexane rings has to be accepted with reserve.

The bicyclic terpenes themselves which come in for attention next are conveniently divided into (*a*) Camphane-Fenchane, (*b*) Santane, (*c*) Pinane, (*d*) Thujane, and (*e*) Carane series. The various sections are again divided into subsections, evidently for the purpose of lucid presentation. The outstanding and recent contributions are described and the work done by the President and his students is incorporated at appropriate places.

In the camphane-fenchane series, reference is at first made to the recent syntheses of parent compounds, like *norbornylane* (Komppa and Beckmann, 1934), endocamphene (Lipp and others, 1927), *d* and *l*-epi-camphor (Bredt, Asahina, 1929, 1933), homocamphor (Lapworth and Royle, 1920), and β-homocamphor (Salmon Legagneur, 1931). The very useful "diene" reaction of Diels-Alder as applied to the synthesis of important substances in this series (1929–1931) including camphene and camphor is dealt with. The syntheses of degradation products like camphenic (Lipp, 1914), homo*apo*fenchocamphoric (Bardhan and others, 1935), *apo*fenchocamphoric (Short, 1927) and Balbiano's acids (Bardhan, 1928) are briefly described and those awaiting synthesis are pointed out. The tricyclic compounds derived from members of this

*In order to draw the attention of the scientific world to some of the important and interesting features of Dr. P. C. Guha's presidential address to the Chemistry Section of the Indian Science Congress (Indore, 1936) not fully covered by the abstract published in a previous issue of the *Journal* (Vol. 4, No. 7, p. 505) we are publishing above another summary. Chemists in India will feel indebted to Dr. P. C. Guha for his admirable and learned address bearing on an important branch of research in Organic Chemistry.—ED.

group are then referred to, after which a discussion of the Wagner rearrangement and the more recent but related Nametkin rearrangement is taken up. This is followed by a sub-section on the physiological action of compounds of the camphor group in relation to their chemical structure.

In the section on santane series, the recent syntheses of santenic (Komppa, 1932, 1934) and homosantenic acids (Sen Gupta, 1933) and that of ketohomo*nor*camphor (Guha and Ranganathan, 1935) are referred to, amongst other facts. The syntheses of santene (Diels and Alder, 1931) and santene glycol (Mohunta and Ray, 1934) are asol described.

In the pinane series, attention is first drawn to the chemistry of more important members of this group, for which purpose they are divided into hydrocarbons, alcohols, aldehydes, ketones and acids, and dealt with separately. Many a knotty problem in constitutional work amongst these compounds are brought out and fully discussed. The synthetic investigations in the field are then taken up; the partial syntheses of α- and δ-pinenes (Ruzicka and collaborators, 1920–24), the synthesis of norpinic (Kerr, 1928, and Guha and Gaind, 1934) and pinononic acids and that of ketonopinone (Guha and Ganapathi, 1935) find mention. Before passing on to thujane series, certain facts are presented which are compatible only with the assumption that the two rings in pinane are in different planes.

The nature of the difficulties that are confronted in work in thujane series are stated. The *cyclo*propane ring in thujane skeleton is easily broken up by a variety of reagents, giving rise to six or five membered compounds depending on the way the ring opens. The actual amount of synthetic investigation especially among degradation products would appear to be scanty. The partial synthesis of thujone (Ruzicka and Koolhas, 1932) starting from α-thujaketonic acid and that of *nor*thujane and similar compounds (Zelinski and others, 1924-25) are described.

The address closes with a small section on carane series. The recent syntheses of *nor*carane (Ebel and others, 1929), homocaronic acid (Owen and Simonsen, 1933), etc., are referred to and attention is drawn to the constitution of certain compounds which is by no means certain.

The very useful and complete bibliography at the end comprises more than 200 references grouped according to the subject-matter they relate to.

Indian Central Cotton Committee.*

32nd Half-Hearly Meeting.

THE 32nd Half-yearly Meeting of the Committee was held on the 13th January, with Sir Bryce Burt, President of the Committee in the chair. In the course of his speech, Sir Bryce referred to the passage into Law of the Bombay Cotton Control Act which has for its object the elimination of Goghari cotton from the important long staple cotton areas of the Bombay Presidency. "This piece of legislation will undoubtedly go a long way towards improving the quality of the cotton of the Surat tract. It is a necessary corollary to the intensive work of the Bombay Agricultural Department in the areas which the Committee has financed to a considerable extent." Continuing Sir Bryce said, "You will remember that at our meeting in February 1935, we came to the conclusion that complaints arising abroad regarding faults in Indian cotton were occasionally exaggerated because India was not adequately represented at important International Cotton Congresses. It was decided that the Committee should endeavour to arrange for better Indian representation on the International Federation of Master Cotton Spinners' and Manufacturers' Associations, as we were convinced that at all such discussions India should be represented by qualified and properly instructed representatives who could speak with knowledge and authority on present-day conditions. This will now be possible as the Indian Central Cotton Committee has been made an Associate Member of the International Federation."

Sir Richard Jackson, Chairman, Lancashire Indian Cotton Committee, who is touring in India for the second time on behalf of the Committee, was present at the meeting by invitation. He recounted the various measures taken by his Committee to popularise Indian cotton and instanced a firm with 3 mills and 300,000 spindles which 3 years ago was using only 10 to 20 per cent. of Indian cotton but was now using over 90 per cent. of Indian. The Committee passed the following resolution :—

> "The Indian Central Cotton Committee desires to record its appreciation of the excellent work of the Lancashire Indian Cotton Committee. The large increase in the takings of Indian Cotton in the last 3 years is a striking testimony to the efficiency of their organisation and propaganda."

The Committee endorsed the decision of the Agricultural Research Sub-Committee, to send a member of the Staff of the Institute of Plant Industry, Indore, to Iran (Persia) to make a comparative study of Indian and Iranian herbaceum cottons. This study is to be undertaken with a view to examining the possibilities of growing cottons of better staple in those parts of Gujerat and Kathiawar which at present grow mixed short staple cottons.

The Committee approved a number of new research schemes including a botanical survey of

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* From the reports issued by the Publicity Officer, Indian Central Cotton Committee.

Kathiawar cottons and the extension of several old schemes.

The Committee also considered a very interesting report on the work done by their Physiologist at Lyallpur on the causes of partial failures of the Punjab cotton crop and bad boll-opening. There are indications that the cause has been found and the Committee approved an additional grant for 1936–37 to enable this interesting discovery to be pursued and the causal or non-causal nature of certain organisms which are associated with this "disease" to be studied.

The Report of the Cotton Forecast Improvement Sub-Committee was approved. Very considerable progress has been made in tracing and eliminating source of error in the major cotton forecasts. A Cotton Crop Forecast Improvement Scheme for the Bombay Presidency was sanctioned in 1934 with the object of improving the accuracy of cotton crop forecast estimates for the Bombay Presidency and Sind. The Committee sanctioned the extension of the Scheme for undertaking full programme of work for a further period of 3 years, after which it is hoped that the respective Governments will continue the work at their own expense.

The Progress Reports of the Director of Technological Laboratory, Matunga, and the Publicity and Propaganda Officer were approved by the Committee, who recorded their appreciation of the work of these officers in their respective spheres.

Science Notes.

Fossil Finds in the Wardha District.—Recently the Nagpur Museum received a quantity of fossil wood and other rocks collected on the Arvi Range of the Wardha district by the Assistant Sylviculturist of the Forest Department. Amongst them are the basal portions of two palm trunks which are of interest as they come from a new locality.

They are of Intertrappean age and Mr. V. B. Shukla, Professor of Botany, Science College, Nagpur, has undertaken the study of them in conjunction with Professor B. Sahni of Lucknow and sections are being prepared. So far they appear to belong to the genus Palmoxylon and one of them appears to be an aquatic form.

The same locality has also produced the fossil *Bulimus prinsepii*, zeolistic amygdules resembling nutmegs, tourmaline, quartz, magnetite quartz rock, ferruginous gneiss and sandstone, serpentine, epidote conglomerates, mica schist, granite, ochres, travertine, etc.

* * *

Neanderthalers lived in Italy as well as elsewhere in Europe during the early days of the old Stone Age. This is confirmed according to a report in *Science* (Dec. 20, 1935, Suppl. 7) by the discovery of a second Neanderthaler skull at Saccopastore in the Tiber valley. A Neander skull was found in Italy several years ago, but since it was the only one known, it might have been a "Stray". The discovery of this second skull in the same geological formation and accompanied by the bones of animals used for food, is regarded as strong evidence that Italy once had its population of Neanderthalers. Dr. Blanc of the Geological Institute of Pisa and the Abbe Henri Breuil of the Palæontological Institute of Paris reported the find.

* * *

It is announced that Dr. Lothar F. Zotz, Curator of Pre-History of Breslau, has discovered in Schleswig, a cave where Ice Age cave bears lived and where Ice Age cave men lived after killing the bears. Many implements and utensils made of the bones and teeth of the monstrous bears have been discovered and there are abundant charcoal remains of the old hunters' fires.

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The Flora of Gujerat including Cutch and Kathiawar.—We have recently received a book on the Flora of Gujerat in Gujerati. This is the first of its kind in any vernacular of India, so far published. The book is particularly welcome as an attempt is made for the first time to carry the results of scientific researches to the non-English knowing public and we hope to see this example set by Prof. S. C. Dixit, the author of the book (Prof. S. C. Dixit, Wilson College, Bombay 7) to be followed by others. No emphasis need be laid on the need for books on scientific subjects in various vernaculars. We congratulate Prof. Dixit on his pioneering work.

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The Influence of Method of Picking on the Quality of Cambodia Cotton.—Frequent complaints made by consumers of Indian cottons both in India and abroad as regards the amount of trash present in Indian cottons are mostly due to careless and faulty picking. The method usually employed by the ryots was to let the coolies collect the seed-cotton in gunny bags, who gathered all available bolls indiscriminately, regardless of the fact whether they were fully ripe or green and immature. The kapas were later removed and sold at the nearest shandy without being dried, and the lint obtained from it was generally moist, weak and the seed was found to be green and not fully ripe.

The Madras Agricultural Department recommended an improved method according to which, the kapas were picked only from the fully opened and mature bolls leaving the locules in the plant itself. This not only gave mature lint and ripe seed, but also the seed-cotton contained fewer leaf bits and was generally cleaner than that obtained according to the cultivator's method. Two samples picked according to these two methods were tested at the Technological Laboratory, Matunga. The results showed that cotton picked according to the improved method was superior in all respects. (Indian Central Cotton Committee Technological Laboratory, November 1935, *Leaflet* 5.) It contained a higher percentage of mature fibres, gave 3 per cent. less total loss in the opening and cleaning processes, registered fewer breakages in the ring frame and the yarns spun from it were definitely stronger and less neppy than those given by the sample picked according to the cultivator's method.

* * *

Electrical "Eye".—An electron tube device, sensitive to both visible and invisible light was

demonstrated by Drs. Zvorykim and Morton before the American Association for the Advancement of Science. The Device comprises of an electron image tube of high overall magnification fitted with a fluorescent screen which acts as an artificial retina. The incident light (whether in visible or invisible range) operates directly the cathode emitter of this tube, as it is sensitive to radiations over the whole spectrum from 1,800 Å to 13,000 Å. Thus an incident radiation (either in ultra-violet or infra-red portion of spectrum) will cause a visible image to be formed on the fluorescent screen. It is quite possible that this 'Electrical Eye' if developed further, will be of the greatest assistance in solving problems of navigation in fog in water or air, and in astronomical and biological work.

* * *

Disintegration of Atoms.—An electro-magnet weighing 58 tons formerly in use at the Annapolis, U. S. naval wireless station, has been transferred to the physics laboratories at Columbia University in connection with a fresh attack that is to be delivered on the atom. (*Electrician*, Jan. 3, 1936, 2.) The field of 14,000 to 15,000 gauss that can be created by this magnet is 75,000 times greater than that of the earth. Protons and deuterons are to be introduced into this magnetic field and directed under the accelerating chamber devised by Prof. Lawrence of California University. Atomic projectiles with an energy of 15,000,000 V. will be emitted and the maximum energy that the equipment will produce is 20,000,000 V. It is hoped that this will enable the atoms of heavy elements such as gold, silver and lead to be disintegrated and that the creation of radioactive elements more powerful and much less costly than radium will be possible.

* * *

Tobacco plants as tall as trees are among the strange vegetation of the lower Andean country now being investigated by an expedition from the University of California under Prof. T. H. Goodspeed. (*Science*, Dec. 20, 1935, Suppl. 7.) One of the biggest tobacco growths measured by Prof. Goodspeed was sixty feet high. The expedition is engaged primarily in a search for wild relatives of the common cultivated tobaccos, to be used in hybridisation experiments. Seeds of many other kinds of plants, however, are being collected.

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Fire Walking.—The University of London Council for Psychical Research has issued a special report on the recent performances before scientific witnesses of Kuda Bux, the Kashmiri Fire-Walker, who walked bare-foot on charcoal trench fire without apparent injury. According to a *Reuter* message recently appearing in the *Hindu*, the conclusion has been reached that it is possible for a slightly built man with chemically unprepared feet to take four rapid steps on charcoal at 430° without injury to his feet, the average time of contact for each step being approximately half a second. The reasons for the failure of two attempts imitative of Kuda Bux's performance are not clear from these experiments. Sir Leonard Hill suggested that increased immunity from burning was due to the power of the controlling activity of the sweat glands of feet and so they were absolutely dry. It is clear that further experimental research is necessary before the *modus operandi* of fire-walking can be considered to be fully understood.

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Health Conference in Singapore.—The Ninth Session of the Advisory Council of the League of Nations Bureau was held at Singapore on the 15th January. Several representatives of Health departments from all parts of the East attended the Conference which was opened by H. E. the Governor, Sir Shenton Thomas. Lieut.-Col. G. G. Jolly, C.I.E., I.M.S., Public Health Commissioner, Government of India, represented India at the Conference. In the course of his opening remarks, H. E. Sir Shenton Thomas directed attention to the possibility of transmission of disease through the medium of air routes. The delegates discussed the question of the risk to Eastern countries caused by the development of air routes and were particularly concerned with regard to the yellow fever which has so far not extended to Asia. The disease at present was found only in Africa and South America and the first line of defence will be India. The importance of determining by the latest methods, the prevalence or otherwise of yellow fever in countries along the air routes was also stressed.

* * *

Development of Coastal Fishing in Bombay.—Remarkable progress has been made by the Fisheries Department of the Government of Bombay under the direction of Dr. S. B. Sethna. The annual report for the year 1934–35 of the Department of Industries, contains an account of the efforts made by the Department to develop Coastal Fishing in the Presidency. Two motor launches were purchased by the Department and sold to Fishermen on the hire purchase system. These boats were being operated at Jaigad and Ratnagiri and fishermen from neighbouring sites flock to sell their catch to the launches. The fish are rapidly transported to Bombay and arrive from 6 to 8 hours earlier than the catches brought by the ordinary sailing vessels and fetch anything from 60–100 per cent. more price. One more fishing vessel was recently purchased and put into service.

While devoting attention to the development of coastal fishing, the Department has not lost sight of the difficulties experienced in transporting fresh fish to mofussils. It is considered more profitable to increase the fresh fish yield in tanks and wells in up-country areas. As an experimental measure a large tank in the Bandra municipal area has been cleaned out and will be stocked with *Gourami* fish when it gets filled up by monsoon rains. It is also proposed to try experiments with *Calla*.

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Soya bean vs. groundnut cake.—So much is being said and written about soya bean or 'wonder bean' as it is often called, that it is worthwhile examining the merits of this bean in relation to other materials abundantly available in India. In an extensive article appearing in *Hindu* (Jan. 22, 1936) Mr. N. has examined the merits of the question and incidentally refers to the work of Dr. McKenzie Wallis who in 1917 and later, investigated the nutritional value of pressed groundnut cake. The results of his work are reported in Vols. 4 and 6 of the *Indian Journal of Medical Research*. The pressed cake contains 9–10 per cent. oil, 44–47 per cent. protein and 24 per cent. carbohydrates. The corresponding

figures for soya bean are 9, 44–45 and 27. In both cases the protein is said to be highly assimilable and both contain similar amounts of phosphoric acid. Dr. Wallis, as a result of his investigations, produced a product called 'Nutramin' containing 81 per cent. groundnut meal, 14 dried milk and 2 sodium bicarbonate which contained abundant protein, sufficient fat and carbohydrate and mineral salts, especially phosphorus and calcium. It possesses good keeping qualities. A case is thus made out for conducting investigations on available food supplies before taking up experiments on soya bean cultivation.

* * *

Grants to Hand-Loom Industry.—The Government of India have published the report on the Tariff Board and Woollen and Textile Industry together with their conclusions thereon. The Board divides the Industry into woollen and worsted industries. While the Government consider that no case for protection has been made out they are impressed with the Board's view as regards assistance to hand-loom and small-scale industry and announce their proposal to grant, for purpose of scientific investigation, 5 lakhs of rupees spread over 5 years to be administered in the same way as is being done for the silk industry.

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In order to stimulate research problems in the field of air hygiene and to gather and disseminate factual information relating thereto, a Foundation called Air Hygiene Foundation of America Inc., has been formed by a large group representing various industries, with headquarters in Pittsburgh, Pa. The Foundation will also co-operate with and assist other agencies active in this field. Dr. H. B. Meller has been appointed managing director. Under his leadership, a comprehensive investigation has been begun at Mellon Institute of Industrial Research, in which the hygienic, technologic and economic aspects of air contamination, especially by dust, in the industries, will be studied.

* * *

It is learnt that a Society for the Study of Alchemy and Early Chemistry has been founded in London. Scholars of international reputation are members of the Council. Regular meetings will be held to read and discuss papers, and a Journal incorporating discussions of papers, special articles by members, etc., will be published. Those who wish to become members may communicate with the Hon. Secretary, Society for the study of Alchemy and Early Chemistry, 8, Bream's Buildings, Fetter Lane, London E.C. 4.

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The Annual meeting of the Association of Economic Biologists was held on 25th January, 1936. At the meeting the following office-bearers were elected. Mr. V. Ramanathan, L.Ag., Cotton Specialist—*President*; Mr. K. K. Rao, Assistant Sugarcane Expert and Dr. T. Ekambaram, Professor of Botony, Madras—*Vice-Presidents*; Dr. S. Kasinathan, Biochemist—*Assistant Secretary and Treasurer*. The retiring President, Mr. K. Ramiah, Paddy Specialist, delivered an interesting and illuminating address on "Genetics in Rice".

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At a meeting held on 30th July, the Central College Mathematical Society, Bangalore, passed a condolence resolution about the death of Mr. V. Ramaswamy Aiyar, the Founder of the Indian Mathematical Society.

* * *

University of Calcutta—Commemoration Day.—The Commemoration Day celebration was held on January 30th. In the course of his speech, H. E. the Governor of Bengal referred to the future of the University and said, "It has grown because it has answered a need among the people of the Province. Its very growth called new aspirations, new problems into being. So long as it sets itself to face these problems and calls forth to the solution all that is best in the coming generation it will not age with passing years. Its youth will be renewed from generation to generation and its strength will stand deeply rooted in the hearts and lives of men and women in Bengal."

* * *

The Diamond Jubilee of the Cuttack Ravenshaw College was celebrated in the College premises on January 18. All the old boys of the College were invited and many of them attended the function from different parts of Orissa. An exhibition of Utkal economic products, in addition to a Flower Show, was held in the College Arts Block. After the annual business meeting was over, Sir Courtney Terrell, Chief Justice of the Patna High Court, addressed the assembly. He spoke on the prospects of the new Province of Orissa, the question of a High Court and the probability of the College growing into a University in the near future. Mr. Bathija, Principal, spoke on the subject of unemployment.

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We are happy to felicitate Prof. Bawa Kartar Singh on his appointment as Head of the Department of Chemistry, Science College, Patna. He is also the Chemical Advisor to the Department of Industries, Government of Bihar. Prof. Singh is well known for his researches in the field of optical activity of organic compounds. He was Professor of Chemistry and sometime acting Principal of the Ravenshaw College, Cuttack.

* * *

Imperial Council of Agricultural Research:—The Director of Industrial Intelligence and Research Bureau has been appointed member of the Imperial Council of Agricultural Research. The Central Provinces have nominated Rai Bahadur R. V. Pillai, Officiating Director, Veterinary Services, as representative of the C. P. on the Imperial Council of Agricultural Research in the vacancy caused by the death of Major R. F. Stirling.

* * *

The Paris International Trade Fair (*Foire de Paris*, will be held from May 16 to June 2. The exhibitors at the last Fair numbered well over 8,000 representing 35 different countries. As additional ground has been acquired to supplement the area of the Exhibition Park (400,000 sq. m.) there will be plenty of space for exhibitors.

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The First International Conference on Fever Therapy will be held in New York City, in September 1936. The object of the Conference is to collect and crystallise available data regarding fever induced by physical and other agencies. Therapeutics, physiological and pathological phases of fever will also be subjects for discussion.

The International Union against Tuberculosis will hold its session in Lisbon, Portugal from September 8 to 10, 1936.

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It is announced that the 2nd International Congress on Mental Hygiene will be held in Paris, from July 27 to 31, 1936.

* * *

It is understood that the International Committee of Weights and Measures have resolved, at a recent meeting held in Paris, that with effect from 1st January 1940 the "Absolute" (practical) system of electrical units should be used instead of the "International" system which is now in vogue.

* * *

Science announces that Dr. J. Shoemaker of the Hague has accepted the presidentship of the International Congress of Surgery to be held in December in Cairo, consequent on the resignation of Prof. Von Eiselberg due to his advanced age.

* * *

The Bausch and Lomb Saccharimeters.—A simple saccharimeter of the half-shadow type, of sturdy construction, in which are embodied features of a commercial instrument most essential to accuracy, ease and simplicity in cleaning and convenience in manipulation, has been described in a pamphlet recently issued by Messrs. Bausch and Lomb Optical Co., Rochester, New York (Agents for India:—Messrs. Martin and Harris Ltd., 17, Princep St., Calcutta). The instrument is provided with direct reading international sugar scale. The polarizer is either of the Lippich or of the Tellet type as the purchasers may choose; the illumination is provided by a 100-watt-concentrated filament Mazda lamp and a glass filter which has the same optical properties as a 15 mm. column of 6 per cent. potassium bichromate solution. Details can be obtained on application from the manufacturers or their agents.

* * *

A prize of 250 *guilder* has been offered by the Dutch Association for genetics for the best work on the Inheritance of differences in resistance to disease in man and animals. The work must contain a review of the literature, especially regarding diseases of the blood, personal observations and conclusions. Further information can be had from A. L. Hagedorn, Secretary, the Dutch Association for Genetics, Soesterberg, Holland.

* * *

Announcement:—

The India Institute of the Deutsche Akademie at its meeting on January 10th, 1936, decided to offer 16 scholarships in institutions of higher learning in Germany available for Indian scholars of outstanding ability, for the academic year 1936-1937.

The scholarships are as follows.—Medicine, 2; Mathematics, 1; Indology, 1; Chemistry, 2; Physics, 2; German Language and Literature, 2; Engineering, 2; Archæology, 1; Veterinary Science, 1; Agriculture, 1; Mining, 1.

All applications should reach India Institute of the Deutsche Akademie before April 1st, 1936. Applications reaching India Institute later than this date will not be considered. The successful candidates will be notified by air-mail in the month of June, 1936, at the latest.

Applications must *directly* be sent to the following address: Dr. Franz Thierfelder, Hon. Secretary, India Institute of the Deutsche Akademie, Maximilianeum, Munchen, 8, Germany.

* * *

We acknowledge with thanks the receipt of the following:—

"The Agricultural Gazette of New South Wales," Vol. XLVII, Pt. I, January 1936 and Index to Vol. XLVI.

"The Journal of Agricultural Research," Vol. 51, No. 5, September 1935.

"Indian Journal of Agricultural Science," Vol. V, Pt. 6, December 1935.

Department of Agriculture, Dominion of Canada:—

Bulletin No. 92. "Studies in Fruit Diseases VIII.—Preventing Peach Canker." (Publication 480).

"The Philippine Agriculturist," Vol. XXIV, No. 8, January 1936.

"The Allahabad Farmer," Vol. X, No. 1, January 1936.

"Journal of the Royal Society of Arts," Vol., LXXXIV, Nos. 4335-4339.

"American Journal of Botany," Vol. 22, No. 10, December 1935.

"Communications from the Boyce Thomson Institute," Vol. I, No. 28.

"Journal of the Institute of Brewing," Vol. XLII (Vol. XXXIII, New series), No. 1, Jan. 1936.

Carnegie Institute of Washington: "News Service Bulletins," Vol. III, Nos. 27-31.

"Chemical Age," Vol. XXXIII, Nos. 860-863; Vol. XXXIV, No. 864.

"Journal of Chemical Physics," Vol. 3, No. 12, December 1935; Vol. 4, No. 1, January 1936.

"Berichte der Deutschen Chemischen Gesellschaft," Vol. 68, No. 13; Vol. 69, No. 1.

"Russian Journal of General Chemistry," Vol. V (LXVII), Nos. 8 and 9.

"Journal de Chemie Physique," Tome 32, No. 10, December 1935.

"Experiment Station Record," Vol. 73, No. 6, December 1935.

"Transactions of the Faraday Society," Vol. XXXII, No. 1, January 1936.

"Indian Forester," Vol. LXII, No. 1, Jan. 1936.

"Forschungen und Fortschritte," Vol. 11, Nos. 35 and 36; Vol. 12, Nos. 1-3.

Government of India Publications:—"Monthly Statistics of Production of Certain Selected Industries in India," August-October 1935. (Department of Commercial Intelligence and Statistics).

— Do. —List of Publications on Indian Entomology, 1934 (Mis. Bull. No. 7). (Imperial Council of Agricultural Research).

— Do. —"Indian Trade Journal," Vol. CXX, Nos. 1542-1545.

— Do. —"Forest Research in India," 1934-35, Part I.

Government of India Publications :—Department of Industries and Commerce, Bombay : "Annual Report for 1934-35."

— Do. —Lac Research Institute : "Annual Report for 1934-35."

"Quarterly Bulletin of the Health Organization," League of Nations, Geneva, Vol. IV, No. 4, December 1935.

"Scripta Mathematica," Vol. III, No. 4, October 1935.

"Journal of the Indian Mathematical Society," Vol. I, No. 8.

"Medico-Surgical Suggestions," Vol. 1, Nos. 11 and 12.

"Journal of the Annamalai University," Vol. V, No. 1, November, 1935.

"Mathematics Student," Vol. III, No. 3, September 1935.

"Science Forum," Vol. I, Nos. 4 and 5.

"School of Agriculture Memoirs," (University of Cambridge), No. 7.

"Research and Progress," Vol. II, No. 1, January 1936.

"The Micro," No. 3, January 1936 (Post Office Journal of Ceylon).

"Review of Applied Mycology," Vol. 14, No.12; Vol. 15, No. 1.

"Journal of the American Museum of Natural History," Vol. 36, No. 5, December 1935.

"Nature," Vol. 136, Nos. 3451-3452 ; Vol. 137, Nos. 3453-3454 and Index to Vol. 136.

"Journal of Nutrition," Vol. 10, No. 6.

"Ceylon Journal of Science," Section D, Vol. III, Part 4.

"Science Progress," Vol. 30, No. 119, Jan. 1936.

"Scientific American," Vol. 154, Nos. 1-2.

"Indian Journal of Venereal Diseases," Vol. I, No. 4, December 1935.

"Indian Journal of Veterinary Science and Animal Husbandry," Vol. V, No. 4, Dec. 1935.

Catalogues.

Verlag von Gustav Fischer in Jena : "Mitteilungen uber Neuerscheinungen und Fortsetzungen (1936)," No. 1, January 1936.

Wheldon and Westley Ltd. : "Monthly List of Books," January 1936.

Academies and Societies.

Indian Academy of Sciences.

January 1936. SECTION A.—C. V. RAMAN : *First Annual Meeting of the Indian Academy of Sciences.—Presidential Address.* MAX BORN : *Unitary Theory of Field and Matter. I. Classical Treatment. Charged Particle with Magnetic Rest-Moment.* C. S. VENKATESWARAN : *The Raman Spectra of Ortho-Phosphoric Acid and Some Phosphates.*—The step-wise ionisation of H_3PO_4 could be followed from Raman spectra. The structure of PO_4 ion is indicated as tetrahedral. B. SANJIVA RAO AND K. S. SUBRAMANIAM : *The Occurrence of Furan Derivatives in Volatile Oils—III. β-Clausenan and γ-Clausenan.*—γ-clausenan is isomeric with α-clausenan. The methods of isolating the clausenans and their physical properties are described. D. S. NARAYANAMURTHI AND T. R. SESHADRI : *Brucine Sulphate as an Internal Indicator in Titrations with Standard Dichromate Solutions.*—The Brucine sulphate indicator is in certain respects superior to diphenylamine, the colour change from green to bright red being very pronounced. M. RAMANADHAM : *Optic Moments of Organic Molecules in Relation to Crystalline and Magnetic Birefringence.*—The magnetic birefringences have been measured for solutions in carbon tetrachloride of naphthalene, diphenyl and dibenzyl. I. CHOWLA : *Vinogradow's Solution of Waring's Problem* (II). R. ANANTHAKRISHNAN : *The Raman Spectra of Some Organic Liquids under High Dispersion and Resolving Power.*—Benzene, Toluene, Phenol, Chlorobenzene, Pyridine and Cyclohexane have been studied. The structure of the 992 cm^{-1} line of benzene has been discussed in detail. C. V. RAMAN AND N. S. NAGENDRA NATH : *The Diffraction of Light by High Frequency Sound Waves. Part III. Doppler Effect and Coherence Phenomena.*

January 1936. SECTION B.—PRAKASH CHANDRA JOSHI : *Contribution to the Life-History of* Stellaria media *L.*—The megasporogenesis of the plant and the development of the pollen grain have been studied. ALBERTO CARLOS GERMANO DA SILVA CORREIA : *The Mussalmans of Goa.*—The Goanese Mussalmans are a mixed ethnic group, issued of the race crossing between Arabs mostly and the Hindus inhabiting Malabar, Deccan and Konkan. MAKUND BEHARI LAL : *A Review of the Genus* Paramonostomum, *Luhe ; with Descriptions of two New Species and Remarks on the Genera of the Sub-Family Notocotylinæ.* C. R. HARIHARA IYER, R. RAJAGOPALAN AND V. SUBRAHMANYAN : *Estimation of Nitrogen by Fumeless Digestion. Part II.—Products of Oxidative Digestion of Organic Nitrogen and the Procedure for their Inclusion in the Estimate of Total Nitrogen.*—The conditions relating to oxidative digestion have been standardised and successfully applied to the estimation of total nitrogen in soils. A. C. JOSHI AND V. RAMA RAO : *The Embryology of* Gisekia Pharnaceoides *Linn.*—A comparison of the embryological features of Phytolaccaceæ, Aizoaceæ and *Gisekia* reveals that the genus *Gisekia* should be placed in Molluginaceæ, a sub-family of Aizoaceæ. S. C. DIXIT : *The Myxophyceæ of the Bombay Presidency, India. —I.*

The National Academy of Sciences :

January 10, 1936. N. K. SAHA : *On the Reconstruction of the Mass-Defect Curve and the Stability of the Beryllium Isotope* Be_4^7. G. R. TOSHNIWAL, B. D. PANT, R. R. BAJPAI AND B. K. VERMA : *Study of Ionosphere at Allahabad.* N. K. CHATTERJEE : *Studies in the Respiration of Mango Leaves.* SHRI RANJAN : *Studies in the Photochemical Action in Plant Respiration.* N. R. DHAR AND E. V. SESHACHARYULU : *Nitrogen Fixation and Azotobacter Count on the Application of Molasses to the Soil in the Field.*—Quantitative experiments show that there is no correlation between the bacterial numbers and nitrogen added thus indicating that agencies other than

azotobacter, such as sunlight and catalysts like iron and manganese also contribute to the addition of nitrogen. G. T. KALE: *Cytophysiological Researches on the Relative Resistance of Wheats to* Puccinia glumarum *Eriks and Henn.* SATYENDRA RAY: *On the Saha-Srivastava Derivations of Rayleigh-Jeans Law.*

February 1*st.* 1936.—(1) P. L. SRIVASTAVA (Allahabad): *On the Phragmen-Lindelog Principle.* (2) KRISHNA LAL GUPTA (Allahabad): *On the Convergence and the Summability of the Conjugate Series of the derived Fourier Series.*

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THE HILL MEMORIAL PRIZE was awarded this year to Mr. Hrishikesha Trivedi of the Physics Department, Allahabad University. It is awarded biennially on the best research work carried out in the Allahabad University both by students and teachers (excluding the senior ones), during previous two years. The recipient of this year's prize is also the Assistant Editor of the *Proceedings of the National Academy of Sciences*, India.

Asiatic Society of Bengal:

THE 153RD ANNUAL MEETING of the Asiatic Society was held on the 3rd February, with Sir Lewis L. Fermor, Kt., O.B.E., D.Sc., F.R.S., President of the Society, in the chair.

In referring to the demise of H. M. King George V, Sir Lewis said, "Not only as loyal subjects we grieve at the passing of H. M. King George V, but as grateful beneficiaries of the system of government which he personified." He also referred to the death of Rudyard Kipling, Dr. P. T. Bruhl, Lt.-Col. H. W. Acton and Dr. A. C. Woolner.

INDIA'S COAL RESOURCES.

In the course of his Presidential address, Sir Lewis dealt with the problem of the Depletion of India's Coal Resources. From a study of the figures of average annual production and average pit's mouth value per ton of coal for the years 1898 to 1934, it will be seen that a rapid expansion in the demand for Indian coal prevailed up to 1919 when the output reached 22.6 million tons. This expansion was not to continue, for the production of 1934 was only 22.1 million tons and "as the coal fields of India opened in 1919 were able to cope with the existing requirements as well as to develop for the future, the coalfields that have been developed since this date, six in number, have caused a position of potential over-production." "The methods of work in many of the coal mines in India have for many years been such as do not commend themselves to geologists and competent mining engineers. And the tales of fire, flood and subsidence from the Jharia coalfield in particular and the evidence visible to all in the shape of pillars of cloud by day and of fire by night show that the extraction of some 600 million tons of coal between 1898 and the end of 1935 must have meant the depletion of available reserves to a vastly larger extent." Mr. Treharne Rees who was engaged by the Government of India in 1917 to report on the situation in the coalfields of Bengal and Bihar & Orissa, directed attention to four problems, *viz.*, method of extraction, generation of power at the collieries, coking, and handling and despatch of coal at the collieries, and found that considerable economy could be effected under each head. He stressed on the need to improve the methods of extraction and advocated the extensive introduction of hydraulic stowing in the Jharia and Raniganj coalfields. The Coal Committee appointed by the Government of India also referred to the wasteful method prevalent and reported in 1920 that no improvement can be expected without State control of the industry.

The extent of the coal reserves of India of higher grade and therefore the seriousness of the admitted losses in working *vis-a-vis* the available reserves were not known at that time, nor was the extent to which it would be possible by methods of washing to improve the lower grade coals known. "These problems and the question of the reserves of sand available for stowing were therefore entrusted to the Geological Survey of India, for examination." A detailed survey was conducted and the results are incorporated in the 5 Memoirs issued by the Geological Survey of India. Sir Lewis issued in July 1935, a Bulletin on the Indian Coal Reserves "to educate public opinion in India on the seriousness of the situation prior to the introduction by Government of measures of conservation, which, it is no secret, the Government of India has in preparation." In the note on India's coal reserves, it is pointed out that the 4,500 million tons of coal of good quality would be exhausted in 100 years. It also draws attention to the more serious fact that the 1,700 million tons of coking coal so essential to the existence of the iron and steel industry will last on the average only 33 years from 1932, at the present rate of extraction, and with a recovery of 50 per cent.; but that such coal would last 80 years, if, with sand-stowing, the extraction were improved to 80 per cent. The position is very serious and demands the adoption of practicable and suitable remedies. For various reasons it will be necessary to have a state control of the methods of work as recommended by the Coalfields Committee. The improved methods will incidentally entail the extensive introduction of some method of stowing the voids, usually referred to as hydraulic stowing or sand-stowing. There should be a change in the methods of grading coal, so that certificates are issued only for coal as actually exported. This will entail the sampling and analysis of cargoes as shipped.

"Whilst recognising that the coal industry requires a higher price for coal in the interests not only of the industry, but also of the welfare of India as a whole, my personal anxiety has been that this increased price should not be obtained by the industry except in return for the *quid pro quo* of improved methods of work."

In conclusion, Sir Lewis referred to a scheme which the Government of India are understood to have, for enforcing the conservation of coal in India. "My plea to the coal industry is that when this scheme is made public, they do not proceed to decry every part of the scheme that affects them personally, as was done in 1922, but that instead they welcome the scheme as being in the best interests of all in the long run and that they even invite the Government to take a more effective line, if they consider that Government's proposals are not far-reaching."

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Office-bearers of the Society for 1936.—

President: H. E. Sir John Anderson.

Vice-Presidents: Sir David Ezra, Sir Upendra

Nath Brahmachari, Bahadur, Lt.-Col. R. Knowles, Sir B. L. Mitter.
General Secretary: Mr. Johan van Manen, F.A.S.B.
Treasurer: Dr. S. L. Hora.
Philological Secretary: Mr. S. K. Chatterjee.
Joint Philological Secretary: Shamsu'l 'Ulama Mawlawi M. Hidayat Hosain, Khan Bahadur.
Natural History Secretaries: Biology: Dr. Baini Prashad; *Physical Science:* Dr. J. N. Mukherjee.
Anthropological Secretary: Rai Bahadur Ramprasad Chanda.
Medical Secretary: Lt.-Col. R. N. Chopra.
Library Secretary: Dr. A. M. Heron.
Other Members of Council: Mr. Percy Brown, Mr. C. C. Calder, Mr. N. G. Majumdar, Lt.-Col. N. Barwell, Mr. K. C. Mahindra and Mr. M. Mahfuzul Haq.

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The following awards were made.—
Elliott Prize for Scientific Research: The prize for the year was awarded to Mr. Kalipada Biswas of Royal Botanic Gardens, Sibpore, for meritorious publications on the subject of Botany. The prize for 1936 will be for work in Mathematics regarding which a detailed announcement has been published in the *Calcutta Gazette* and the *Bihar and Orissa Gazette.*

The Barclay Memorial Medal: The medal is awarded to Dr. Birbal Sahni, Professor of Botany, Lucknow University, for his long sustained and distinguished labours in the field of Botanical research. This medal is awarded biennially to any individual for conspicuously important contributions to Medical or Biological science with special reference to India.

Joy Gobind Law Memorial Medal: The Medal is awarded to Professor Lew Semenowitch Berg, Chief of the Bureau of Applied Ichthyology and Professor of Geography, State University, Leningrad, Russia. This medal is awarded every three years for conspicuously important contributions to the knowledge of Zoology in Asia.

Indian Physical Society:

THE SECOND ANNUAL MEETING of the Indian Physical Society was held on the 6th January, 1936, in the room of the Section of Mathematics and Physics, Indian Science Congress, Indore, with Prof. A. C. Banerjee, M.A., I.E.S., in the chair.

As a result of scrutiny of the ballot papers the Council for 1936 was constituted as follows:—
President: Prof. M. N. Saha, D.Sc., F.R.S., (*Allahabad*).
Vice-Presidents: (1) Principal B. M. Sen, M.A., I.E.S. (*Calcutta*); (2) Prof. G. R. Paranjpe, M.Sc., I.E.S. (*Bombay*).
General Secretary: Prof. D. M. Bose, M.A., Ph.D. (*Calcutta*).
Treasurer: Prof. P. N. Ghose, M.A., Ph.D., Sc.D. (*Calcutta*).
Members of the Council: (1) Prof. K. Prasad, M.A., I.E.S. (*Patna*); (2) Prof. J. B. Seth, M.A., I.E.S. (*Lahore*); (3) Dr. S. K. Banerjee, D.Sc. (*Poona*); (4) Prof. B. B. Ray, D.Sc. (*Calcutta*); (5) Prof. N. R. Sen, Ph.D., D.Sc. (*Calcutta*); (6) Prof. H. P. Waran, Ph.D., D.Sc. (*Madras*).

February 8, 1936.—At a special meeting held in the Chemistry Lecture Theatre, University College of Science, Calcutta, the following papers were read:—

Prof. M. N. Saha—The Origin of Mass in Neutrons and Protons. H. K. Trivedi—The Nature of Binding in $SnCl_2$.

Indian Chemical Society:

December 1935. DINES CHANDRA SEN: *Studies in the Camphor Series. Part II.—Synthesis of isonitrosothiocamphor and its Application as an Indicator in Acidimetry and Alkalimetry.* N. R. DHAR AND S. K. MUKHERJI: *Denitrification in Sunlight and its Retardation. Part II.* SUSIL KUMAR RAY: *Parachor and Ring Structure. Part II.—The Spatial Configuration of Bridged-ring Compounds.* MAHAN SINGH AND MANOHAR SINGH: *Studies on Optical Activity and Chemical Constitution. Optically active Acids and Bases—Part II.* N. R. DHAR AND R. N. MITRA: *Condition of Iodic Acid and Iodates in Aqueous Solution.* VISHWANATH SHARMA AND SIKHI BUSHAN DUTT: *Metallic Titanium in Organic Synthesis.* SUSIL KUMAR RAY: *Parachor and Chemical Constitution. Part IV.—The Structure of Aliphatic Diazo-compounds.* KUVERJI GOSAL NAIK AND BANSIDHAR VITHALDAS MEHTA: *Mercury Acetamide as a Mercurating Agent. Part II.—Mercuration of Phenols.* DATTATRAYA BALKRISHNA LIMAYE AND GOVIND RAMACHANDRA KELKAR: *Action of Acetic Anhydride on 2-Acetylresorcin. A New Method for the Synthesis of γ-Resorcylic Acid.* DUKHAHARAN CHAKRAVARTI AND BAIDYANATH GHOSH: *Synthesis of Coumarins from Phenols and β-Ketonic Esters. Part V.—Constitution of Chlororesorcin and Chlororesorcylaldehyde.* KALI PADA BASU AND SACHINDA NATH SARKAR: *A Semi-micro Method of Determining Total Nitrogen of Air-dry Soils.* S. S. BHATNAGAR, M. B. NEVGI AND MOHAN LAL KHANNA: *Ionic Susceptibility of Rubidium from its Different Salts in the Solid and in the Dissolved State.* P. G. DESAI AND A. M. PATEL: *Solubility of Benzoic and Salicylic Acids in Mixtures of Organic Solvents.* R. M. HALASYAM: *A Note on the Constitution of Formic Acid and Formates.*

Indian Botanical Society:

THE ANNUAL MEETING of the Indian Botanical Society was held at Indore (C.P.) on January 6th, 1936. The following office-bearers were elected for the new year:—
President: Dr. S. R. Bose, M.A., D.Sc., F.L.S.
Vice-Presidents: (1) Prof. P. Parija, M.A., I.E.S.; (2) Dr. K. Bagchee, D.Sc., D.I.C.
Business Manager and Treasurer: Prof. M. O. Parthasarathy Iyengar, M.A., Ph.D., F.L.S.
Councillors: (1) Dr. S. P. Agharkar, M.A., Ph.D., F.L.S.; (2) Dr. B. Sahni, M.A., D.Sc., Sc.D., F.G.S.; (3) Dr. J. H. Mitter, M.A., Ph.D., F.L.S.; (4) Prof. R. H. Dastur, M.Sc., F.L.S.; (5) Mr. K. Biswas, M.A.; (6) Dr. T. Ekambaram, M.A., Ph.D.; (7) Dr. Y. Bharadwaja, M.Sc., Ph.D., F.L.S.; (8) Dr. P. Maheswari, D.Sc.; (9) Dr. S. L. Ghose, M.Sc., Ph.D., F.L.S.; (10) Mr. H. G. Champion, I.F.S.
Member on the Editorial Board: Dr. H. Chaudhari, M.Sc., Ph.D., D.I.C.
Honorary Secretary: Dr. E. K. Janaki Ammal, M.A., D.Sc., Imperial Sugarcane Station, Lawley Road P.O. (*via*) Coimbatore, S. India.

University and Educational Intelligence.

Allahabad University:

Court.—The Court at its meeting held on 4th December, 1935, re-elected Pandit Iqbal Narain Gurtu, M.A., LL.B., as Vice-Chancellor of the University for a further period of 3 years.

Convocation.—On the 5th December, 1935, a convocation of the University for conferring degrees and diplomas was held when His Excellency Sir Harry Haig, Governor of the United Provinces and Chancellor of the University presided. His Highness the Ruler of Bhopal delivered the Convocation address.

Degrees.—The degree of Doctor of Science was conferred on Messrs: (1) P. K. Sen Gupta, (2) D. N. Chakravarti, (3) G. Gopalarao, (4) N. N. Ghatak.

Staff.—Mr. Dhirendra Varma, Head of the Hindi Department and Mr. R. K. Saksena have returned from Europe after taking the degree of D.LITT. and D.SC. respectively from the University of Paris.

Special Lectures.—Prof. Noguchi, Poet-Laureate of Japan who was invited by the University delivered two lectures on "Some Aspects of the Arts and Literature of Japan."

Appointments.—Mr. Hari Har Prasad Dube, B.A., has been appointed as Chief Instructor of Physical Training with effect from January, 1936.

Annamalai University:

Special Lectures.—Under the auspices of the University, the following gentlemen delivered courses of special lectures during January 1936, on the subjects noted against their names:—

Mr. K. R. Subrahmaniam, Professor, Maharajah's College, Vizianagaram; three lectures on "The Ikshvakus of Andhra".

Prof. A. Gopala Menon, M.A., B.COM. (Lond.), Maharajah's College, Trivandrum, three lectures on "Agricultural Indebtedness and Some Remedies."

Dr. B. L. Manjunath, M.SC., D.Phil. (Oxon.), four lectures on "The Chemistry of Plant Products."

Prof. Yone Noguchi of Japan, three lectures on "Japanese Arts and Poetry".

Technology.—The Syndicate has appointed a Special Committee to investigate the possibilities of starting at an early date a department of Oil Technology in this University. A draft scheme involving a recurring cost of Rs. 16,070 and a capital expenditure of Rs. 70,000 suggested by its Sub-Committee is under consideration.

New Degrees.—It has been decided to institute a Ph.D. degree awardable on the basis of a thesis embodying the results of approved research work done for a prescribed period. Regulations governing the award of the degree are under consideration.

Deputations.—The following members of the Staff attended, as delegates of the University, the Conferences noted below:—

Prof. Rao Sahib C. S. Srinivasachariar and Prof. K. Rama Pisharoti.—The All-India Oriental Conference at Mysore.

Mahavidwan R. Raghava Ayyangar.—The First All-India Oriental Poets' Conference, at Mysore.

Prof. A. Narasinga Rao and Mr. B. Ramamurti.—The Mathematical Conference at Delhi.

Dr. B. V. Narayanaswami Naidu and Mr. M. K. Muniswami.—The 19th All-India Economic Conference at Dacca.

Dr. S. Ramachandra Rao.—The Annual Meeting of the Indian Academy of Sciences, Bombay.

The Vice-Chancellor opened the 11th All-India Educational Conference at Nagpur. He has been nominated to represent the University at the Quinquennial Congress of the Universities of the British Empire to be held at Cambridge in July, 1936.

Mr. R. G. Grieve, M.A., C.I.E., D.P.I. (Madras) (Retired), the representative of the University on the Universities Bureau, has also been appointed a delegate for the Quinquennial Congress.

Aligarh University:

Prof. Max Born's Visit.—Professor M. Born paid a visit to the Muslim University on the request of the authorities from the 5th to the 9th of January. During this time he gave a course of lectures on wavemechanics and a popular lecture and took part in many discussions and colloquia with the Aligarh Scientists concerning the problems now engaging their attention.

Before he delivered the popular lecture, Professor Born was introduced by Dr. Zia-Uddin Ahmed, the Vice-Chancellor of the University, to the staff and students of the University. Dr. Zia-Uddin, in welcoming Prof. Born, paid a glowing tribute to the extraordinary merits of Prof. Born as a scientist of prolific activities. He mentioned particularly his contributions to the theory of relativity, the dynamic theory of crystals and to many problems of atomic and molecular physics. He emphasised the importance of his work which paved the way for the discovery of quantum mechanics, for which his pupil Heisenberg, who worked the last step, was awarded the Nobel Prize. Prof. Born, in expressing his thanks, recollected the many former associations with Dr. Zia-Uddin as his class-mate in Goettingen. He expressed his great satisfaction at the work, which is being carried on in the Physics Department, where his old friend and pupil Prof. R. Samuel continues the tradition of Goettingen with his collaborators.

In the course of his lecture, Prof. Born touched upon the relation between technical and pure science. He was convinced that technical and industrial progress can be achieved best by an efficient education in pure science. This opinion was based on the industrial development of Germany, which he had watched closely for many years and which was mainly due to the pure scientific research work of University professors in their small laboratories.

During his course of lectures, Prof. Born dealt with the wave-mechanical theory of valency; it was interesting to note that he preferred any development in which the basic ideas of Heitler and London's original theory gained more prominence. He welcomed the results of many experimental investigations, carried out in Aligarh which all lead to this view-point.

The visit of Professor Born and his inspiring lectures and presence, have left a deep impression.

Calcutta University:

The following delegates have been appointed to represent the University on the next *Quinquennial Congress of the Universities of the Empire* to be held at Cambridge :—

Mr. Syamaprasad Mookerjee, M.A., B.L., BAR-AT-LAW, M.L.C.

Mr. Bidhanchandra Roy, B.A., M.D., M.R.C.P., F.R.C.S., F.S.M.F.

Prof. Sisirkumar Mitra, D.SC.

Sir William Ewart Greaves, Kt., M.A., D.L.

The following are some of the subjects suggested by the University for discussion at the above Congress :—

State Control and Universities—particularly in relation to Grants.

Careers for University Students.

Interchange of Professors among Universities of the Empire.

Universities and Secondary Education, particularly in relation to training of teachers.

Availability to Indian Universities of Scholarships and Fellowships awarded in the United Kingdom to Universities of the Empire.

Student Health and Universities.

Dacca University:

At its meeting held on Saturday the Dacca University conferred the honorary degree of Doctor of Science on Sir J. C. Bose and Sir P. C. Roy and the honorary degree of Doctor of Law on H. E. Sir John Anderson, Governor of Bengal and Sir Abdur Rahim, President of the Legislative Assembly. Honorary degrees of Doctor of Literature were conferred on Sir Jadunath Sircar, Poet Rabindranath Tagore, Mr. Sarat Chandra Chatterjee, the famous Bengali novelist, and Sir Muhammad Iqbal.

Delhi University:

Dr. Ruth Young, Principal, Lady Hardinge Medical College, is appointed member, Council of Delhi University, *vice* Dr. C. D. Houlton, resigned.

Mysore University:

Personnel.—(1) Mr. F. N. Mowdawalla, M.A., B.SC., MEM.A.I.E.E., M.I.E. (Ind.), Principal, College of Engineering, who was on leave, was, on his return from leave, transferred as Chief Electrical Engineer in Mysore.

Mr. D. Srinivasachar, M.A., Professor of Sanskrit, Maharaja's College, whose present term of service expires on the 31st March 1936, has been permitted to retire from the 1st April, 1936.

Meeting of the Academic Council.—A meeting of the Academic Council was held on 10th January, 1936.

Among the decisions arrived at the meeting, mention may be made of the following :—

(1) That candidates successful in the M.A. and M.SC. degree examinations should be classified in two classes.

(2) That of the four members to be elected by the Academic Council to the Senate, one may be elected from each of the four Faculties (Arts, Science, Engineering and Medicine).

Examinations.—The results of the Pre-Medical and the First M.B.B.S. examinations held in December 1935 were published during the month, as follows :

	Pre-Medical.	First M.B.B.S.
Number Examined ..	28	11
Number Passed ..	20	8
Percentage	71.4	72.7

Extension Lectures.—The following extension lectures were delivered :—

(*a*) Sir Martin Forster, F.R.S., on "Chemistry in Modern Warfare" in English at Bangalore and Mysore.

(*b*) Mr. M. Hayath, B.E., B.S.E.E., on "Electricity in the Service of Man" in English at Shimoga and Davangere.

(*c*) Mr. A. R. Wadia, B.A., BAR-AT-LAW, on "(1) The State in Contemporary Political Philosophy; (2) The Law of Karma in relation to the Individual and the Society," in English at Hassan.

Spun-Glass Wool.

A new factory for twisting glass fibres into thread or yarn for textiles is being established in Corning, N.Y. by the Corning Glass Works. After 11 years of research, the industrial possibilities of 'Spun-Glass Wool' have been realised, though glass wool was first developed in Germany (*Christian Science Monitor*, December 17, 1935). It is expected that the manufacture of glass awnings, tentage, bed-coverings, tapestry and eventually articles of clothing will become possible in course of time.

The new textile is extremely pliant. The molten glass is forced through tiny orifices under very high pressures. When hardened the fibres are so fine that nearly 90 of them are needed to form the equivalent of No. 60 thread. It can be spun into yarn and woven on standard textile looms and can withstand pressures up to 1,000,000 pounds a square inch. In the chemical laboratory it has been found excellent for insulation and filters.

At the same time, a process is being developed by the Owens-Illinois Company in Newark, Ohio, which enables molten glass to be assembled on a conveyor line in a fluffy mass, a downy substance that can be wound on spools and twisted into silk like thread and yarn on regular textile machines. A few experiments conducted on the new material, such as the knitting of a purse or pieces of embroidery work and the weaving of a glass rug about six feet long and three feet wide—which, curiously enough, cannot be easily distinguished from articles made of linen and other common fabrics—are all indicative of great industrial possibilities, though they are only novelties now.

Reviews.

Vitamins in Theory and Practice. By Dr. Leslie Harris, SC.D., D.SC. (Cambridge University Press, 1935.) Pp. 240. Price 8*s*. 6*d*.

Dr. Leslie Harris has produced a pleasantly readable book wherein he conducts us in the space of nine chapters through the vast but fascinating field of Nutrition. He recounts the relevant facts concerning the nature and discovery of the various vitamins, and deficiency diseases caused solely by a lack or deficiency of one or more of the known vitamins are also dealt with, albeit briefly. The nine chapters form a continuous story; the final chapter on "Dietetics—What to eat?" is a fitting conclusion to an interesting story narrated in vivid and fairly non-technical language.

To the advanced student of Nutrition, the book has not much to impart; it is based on a series of four afternoon lectures at the Royal Institution. But the author's aim—to present a readable narrative of that truly romantic subject, the history of vitamin discovery and research—is amply fulfilled. The non-scientific reader will readily derive from the book an insight into the trend of modern nutrition research and its important practical applications. The results of a great deal of experimental work are compactly described, and the reader is spared abstruse details of laboratory technique.

The book is profusely illustrated with photographs, including a considerable number of full-page ones. Its get-up leaves very little to be desired and it is provided with a good index.

S. R.

Essentials of Physiological Chemistry. By Arthur K. Anderson, PH.D. (John Wiley & Sons, Inc., New York: Chapman & Hall, Ltd., London. 1935.) Pp. 257. Price 13*s*. 6*d*.

Granted that the notable advances in chemistry in recent years have been in the border line between chemistry and other sciences such as physics, botany, physiology and medicine, a basic knowledge of pure inorganic and organic chemistry is surely essential for a study of physical, physiological or pharmaceutical chemistry. To attempt, therefore, an exposition of physiological chemistry for a student "with a limited preparation in chemistry" is fraught with danger and difficulty. A popular account, addressed solely to the layman, would be understandable; but the book under review essays a serious treatment of a very complex subject, presupposing, however, ignorance on the part of the reader of all but the elements of physical and organic chemistry. To any one who has gone through an Honours school of chemistry, large portions of the book would be a needless duplication of matter found in the common text-books; to the rest they would be more or less incomprehensible. The book itself is exceedingly well written and makes fascinating reading, but it suffers from the limitations of its own objective. One result is a certain lack of proportion; thus much valuable space is occupied in explaining elementary organic chemistry such as osazone formation, the optical activity of tartaric and lactic acids, methods for the estimation of the reducing sugars (with the exclusion of the Lane-Eynon method), the structure of glycerol and the hydrogenation of oils, while a very unsatisfying account is given of the hormones and the vitamins. The sterols get less than a page; the synthesis of thyroxin finds only a passing reference; the syntheses of ascorbic acid are not even mentioned. In view of the work of Mark, Meyer and Haworth on the structure of cellulose, the inadequacy of the latter being summarised in the single sentence "Irvine believes that the fundamental unit in cellulose is a glucose trisaccharide" is apparent. The action of alkali on cellulose does not produce a "a hydrocellulose which is familiar in the form of mercerised cotton". If essential oils are relevant to an introductory course in physiological chemistry, there is little hope of imparting any kind of knowledge of the field in eighteen lines; incidentally it is not easy to see the point in the chemical classification of essential oils into "esters, aldehydes, ethers and terpenes".

One aspect of the book has perhaps been needlessly stressed and it is necessary to reiterate its general excellence. The material is of engrossing interest; a comprehensive and very readable survey has been made of a subject of the utmost complexity. The presentation is lucid and as an introduction to physiological chemistry the book is a valuable addition to the chemist's library.

K. V.

The Systematic Identification of Organic Compounds—A Laboratory Manual. By R. L. Shriner and R. C. Fuson. (John Wiley & Sons, Inc., New York ; Chapman & Hall, Ltd., London, 1935.) Pp. ix+1935. 11*sh*.

Considering the paucity of good manuals for the use of students, the present work of Professors Shriner and Fuson, is most welcome, particularly as it is the outcome of the authors' long and evolved experience in training students of organic chemistry in the University of Illinois. The methods portrayed, therefore, possess the merit of having been tested and tried, and should appeal at once to the student preparing for a University examination and to the research worker.

The book is divided into nine chapters. After an introductory chapter, the student is introduced to solubility tests, by means of which a given compound is brought into one of nine groups based on their solubility behaviours in various liquids. A few fundamental aspects of solubility are discussed, such for instance as the influence of branched chain on solubility, the relation of molecular weight to solubility, an understanding of which will provide some clue as to the nature of the substance. It should be remembered that qualitative analysis demands a critical insight into the operations employed and the analyst has to work not only with open eyes but also with an open mind. From this point of view, the treatment of the subject will commend itself to the students. The use of classification reagents is described in the 3rd chapter and it is emphasised that the reagents are not always specific to single functional groups, but possess limitations. Such limitations are further discussed. The chapter on the preparation of derivatives comprising nearly half the volume is a very instructive one with useful notes and copious tables giving physical constants of important derivatives of a large number of the more common organic compounds. An additional feature is the citation of a few select references to original literature which will prove invaluable.

The book is a very useful addition to the existing literature and will be welcomed by students preparing for University examinations. It may, however, be remarked that important applications of organic chemistry are to be found in the fields of biology and medicine, and more elaborate treatment of naturally occurring organic compounds possessing physiological interest, would have been desired ; this is particularly so, because not a few students undergoing preliminary instruction in organic chemistry, later take up the study of biochemistry and medicine, and such a chapter would have formed a useful addition.

Bacteria in Relation to the Milk Supply. By C. H. Chamers. (Edward Arnold & Co., London, 1935.) Pp. 192. Price 6 *sh*.

The book is divided into two parts. The First Part treats of the bacteriological control of milk and is divided into five chapters. The routine examination of milk, the routine examination of water, the causes of taints and abnormal conditions in milk, the isolation and identification of organisms from milk and control of the dairy plant are dealt with in this Part. The Second Part in eight chapters deals with laboratory regulations, cleaning and sterilization of apparatus, preparation of media, isolation and purification of organisms, inoculation, incubation and identification of bacteria.

In the appendices the author has given the important media, composition of stains and chemical reagents for carrying out the work described in the two Parts. A copy of the standard bacteriological tests for graded milk (Memo 139 Food Ministry of Health) is also given. One short chapter is devoted to the description and use of the microscope.

As the author has more or less completely dealt with all the phases of bacteriology in relation to milk supply in the short space available, this small book will be indispensable to dairy students in general and workers in dairy bacteriology in particular. It is interesting to observe that the author has not left the minute details for reference to other higher works on the subject. Examples of these are :—" Counting of bacteria on milk smears ", " Calculation of magnification on the microscope ", "Measurement of bacteria", "Gram, flagella and capsule staining" and "Filtration ". Nature and causes of abnormal conditions of milk, such as bitterness, oiliness, sliminess, fishiness, caramel, phenol and alcohol flavours have also been properly dealt with in this book. Methods have been indicated for testing addition of

colouring matter and preservatives to milk. Under the identification of bacteria, different forms of bacteria have been illustrated. Methods for detection of indol, phenol, acetyl-methyl carbinol, etc., have been given in detail.

Detailed descriptions of some of the ærobic spore-bearing rods, the acid producers, the peptonising organisms and pathogenic organisms occurring in milk are very useful additions.

Although the author has only attempted to present a guide for the routine examination of milk and for the laboratory methods of bacteriological control of milk, the book will be found useful so far as the supply of milk is concerned to dairy students, and as such, it will relieve the teacher of selecting the subject-matter for detailed treatment.

As the author has observed "No publication of this kind can pretend to much originality", so it would have been very useful to both teachers and students if the author had cited some references at the end of each chapter. It is hoped that the author would rectify this omission in the second edition.

N. V. J.

A Text-Book on Forest Management. By M. R. K. Jerram, M.C. (Chapman and Hall, Ltd., London, 1935.) Pp. x+156. Price 10*s*. 6*d*.

An American authority defines a Forest as a "Community of living beings of which the most important member is the tree." The management of so heterogeneous a community raises difficult problems which are rendered all the more complex by factors which are extraneous to Forestry proper, but, which, nevertheless, must be taken into account by foresters. (For example, the financial policy of a Government has an obvious bearing on the management of State forests.) Further, some of these complexities are peculiar to individual forests. Very rarely indeed can the general principles of Forest Management be applied to a given Forest without any modification. A text-book on the subject can, therefore, merely expound the first principles, enumerate and perhaps compare well-known methods of Forest Management. It is the merit of Mr. Jerram's volume that within the compass of some 160 pages, he has succeeded in introducing his reader "to all the more important problems involved, to explain the elementary principles on which their solutions are based, and to provide a framework on which a further knowledge may be built up by lectures, reading and study of practice in the forest itself". (p. v.)

Part I of the book deals with Forest Mensuration. The first principles of measuring stock, growth, increment and yield are clearly explained. It is noteworthy that the author derives his formulæ without the aid of Calculus and his graphical methods give deductions which although correct as a first approximation have the merit of simplicity. Part II discusses the "Preparation and control of a working plan". It is to be feared that in Mr. Jerram's exposition, the control of a working Plan has not received the same attention as its preparation. The most elaborate working Plan is rendered futile, if not properly controlled. And if it be true that in actual practice the control of a Plan—unlike its preparation—does not receive the care it deserves, it is all the more necessary that a text-book should emphasise the dangers attendant on such lapses. Part III of the book is devoted to Forest Valuation and Finance. A summary of the problems dealt with under Forest Finance is masterly in its lucidity and conciseness. It is clearly shown how "there is no such thing as a safe long-term investment outside Forestry." (p. 102.)

At the beginning of some chapters are given the names of books recommended for consultation. At the end of the volume, there are three appendices: the first gives a Vocabulary of terms used in Forest Management, the second, a Table of the future values of £1 in N years @ P% compound interest, while the third appendix gives an extract from a Government of India Resolution on Forest Policy. The book is provided with an Index.

Under "Contents," Part III of the book receives the caption "Forest Finance" (p. ix) while in the body of the book (p. 101) the same part is headed "Forest Valuation and Finance". On page 26, in the derivation of the formula for G. S. (Fig. 9), the letters A, B, C, D are first used to represent *rectangles*, and later, the same letters stand for the *altitudes* of the triangles *fab*, *hac*, etc. This is confusing. To refer to formulæ by dates as "1883 formulæ" (p. 60) is not very elegant. The abbreviation G. S. has been used for the first time on page 3 without

indicating what it stands for. Since the abbreviations employed are many and not always obvious, it would be helpful if an alphabetical list of these with their equivalents is appended to the volume. In the example worked on page 62, in column *f*, the total of 4443 c.ft. is a misprint for the correct figure 4445 c.ft.

This very readable volume forms an admirable introduction to the more exhaustive treatises on the subject.

EMMENNAR.

More Simple Science, Earth and Man. By E. N. Da C. Andrade, D.Sc., Ph.D., F.R.S., and Julian Huxley, M.A., D.Sc. (Basil Blackwell, Oxford, 1935.) Pp. x + 352. Price 6*sh.* net.

This is undoubtedly the best book on elementary science in the English language for school children, and also for those whose education has not included scientific training. The existing practice of teaching science in the secondary schools in water-tight compartments is exposed to the criticism that the pupils get a mass of unrelated facts and obtain no coherent idea of the knowledge placed before them and are generally ignorant of the application of such knowledge to the practical problems of life. This grave reproach to the scientific education in our schools, the book under review removes. It should be welcomed by all the educational authorities and it should replace the books on physics, chemistry, human physiology and hygiene which are individually prescribed at the present moment.

The present volume, which is a continuation of the earlier work '*Simple Science*' by the same authors, is intended to form part of a series of four books adapted for use in all schools. There is one difference between formal text-books on elementary science and those written by Andrade and Huxley. The former are written and taught in the hope that the young pupils would become specialists in some branch of science. But the latter attempt to give the young men a wider view of the scope and applications of science, and this makes all the difference between true education and pseudo-education.

It is superfluous to deal with the chapters individually for comment and when we read them our satisfaction was how some of the difficult topics could be rendered so easily understood by every school child who is reasonably intelligent, and how they could be expressed in such simple language. Science is generally understood by the common people as something abstruse and solemn, fit for the absent-minded professor and the precocious students. Here is a book which without sacrificing precision and accuracy deals with the stern realities and the facts of knowledge in a language understood by all.

The last three chapters dealing with '*The Improvement of Living Things*', '*The History of Science*', and '*Science and General Ideas*' present the history and philosophy of science in a manner at once simple and fascinating. The book is profusely illustrated.

Modern Science. Book II. Chemistry. By G. W. Manfield, B.Sc. (Lond.). (Messrs. Macmillan & Co., London, 1935.) Pp. 156. Price 2*s.* 3*d.*

This fine little book is the second in the series of books on modern science, designed by the publishers. This book deals in a simple manner, with a few substances and their reactions having every-day interest. No reference to the theories on which the science is built is made and symbols and formulæ are not made use of in the course of the discussion.

The book is divided into twelve chapters, each chapter dealing with, in order, air, oxygen, water and hydrogen, water and other liquids, coal, coal gas and petroleum, iron and steel, more useful metals, acids and their uses, alkalies and soap industry, salts and their uses, chemistry in the garden, and the foods we eat. It will be seen that the subjects dealt with are of every-day interest, a knowledge of which is the barest essential in the modern days. Not only can the lay reader use this book, with great advantages for enriching his general knowledge, but the young student, just introduced to chemistry in the secondary schools, will find in this book matter that will prove profitable to him.

The subject-matter in the book is dealt with in a simple language and in conversational style, so that the young pupil will feel quite at home with the reading of this little book. At the end of each chapter a summary is provided. The diagrams are copious and neat.

A list of useful books of reference, an exhaustive set of questions, based on the

subject-matter in the book, and an index make the book particularly attractive.

Europe. By Samuel van Valkenburg and Ellsworth Huntington. (John Wiley & Sons, New York; Chapman & Hall, Ltd., London, 1935.) Pp. x+651. Price 23*s*. 6*d*.

At the present day, the world civilisation is European. The nations of the Americas and Australia claim alike to be descended from an European stock in blood and culture. The oriental countries are rapidly Europeanising themselves. This well-nigh universal admiration for Europe provides the strongest evidence that Europe is still the most dominant continent. In order to understand how great this dominance is, it is not sufficient to confine ourselves to a study of the contrast that exists between Europe and other continents, but a thorough knowledge of the appearance of the various parts and the economic and cultural status of the individual countries is a pre-requisite. Hence the plan of the present volume has been to devote two-fifths of it to a discussion of Europe as a whole, laying special stress on the systematic way in which the continent is divided into zones of culture, which are coincident with geographic environment.

The book, which is the fruit of personal observation and study, presents the combined view-point and methods of an European and American geographer. The impress of wide travel in Europe and other continents on the part of the authors is manifest in the text. The geographic story of Europe can be narrated in several ways, each having its advantages and drawbacks. The authors have viewed the continent as a whole in its physical, economic and human phases. The physical aspects comprise a review of the location, magnitude, climate, relief in reference to geological origin, the soil and natural vegetation. The discussion of vegetation logically leads to the economic and human aspects of geographic study, and specially to problems of land utilisation and the primary industries of agriculture, forestry and fishing. The next physical aspect is the sources of minerals and power, and these naturally introduce chapters on the development of industries and the evolution of transportation and trade. Next the human stock of Europe, which has done so much to mould the modern Europe is depicted in terms of ethnographic history and political divisions.

The book naturally divides itself into two sets of chapters, those designed to portray a comprehensive description of the climate, the appearance and natural regions of the whole continent, and others which give a detailed account of the regional and political geography of the European countries. The section of the book dealing with the climate and relief lays a foundation whereby the succeeding chapters on soil, vegetation, commerce and population build up a picture of the continent as a whole, and is very helpful in preparing the way for the treatment of the individual countries.

The regional geography of any part of the world must needs follow the continental lines, but the unique feature of this section of the book is that the authors have succeeded in presenting a broader view in the understanding of current problems. To the world at large the geography of Europe connotes in a large measure, the geography of countries like the United Kingdom, France, Germany, the U. S. S. R. and Italy. The fates of the smaller countries are in fact determined by the stability of the major ones, as the emergence into being of the Little Entente and the Balkan Entente has amply proved.

That Great Britain has for several centuries occupied a position of outstanding influence in world affairs is universally accepted, although the factors that have contributed to this pre-eminence are debated. The insularity and the location in respect of Europe have above all tended to elevate England to its unique place.

The maritime climate of the British Isles have also played their part in giving England an almost unrivalled place in the field of industry and commerce. The Netherlands and Belgium are another example of how human efficiency in conjunction with a salubrious climate has raised a great nation into industrial and political importance. One of the most distinctive features of French geography is the paramount importance of Paris. The ideal situation of the city and the location in it of nearly all French cultural and political activities make it a veritable barometer of French prosperity. A counterpart to this French situation is to be found in the all-important Po basin in Italy. Although the Italian Peninsula is centrally situated in respect

of the Mediterranean, the most important factor in the rise of modern Italy is still the Po basin, which is not only due to its economic value but also to the quality of its people as well. Even a cursory glance at a map of Europe shows that central Europe is a region of transition. Nordic Scandinavia, Marine Western Europe, the Mediterranean Southern Europe and the topographically uniform Eastern Europe have effectively hemmed in this zone. The transitional character of this section of Europe is evident both in its climate and vegetation and also in the nature of its industries and the political and social institutions of its people. The Swiss with their ethnographic diversity have evolved political unity and have established a truly federal republic. The economic regeneration of Germany since 1870 is one of the most phenomenal of modern times. Here is proof that national progress rests as much on human effort as on such physical factors like relief, soil, climate and mineral resources. The modern development of Germany unlike that of many other countries is a happy blend of industrial, agricultural, commercial and political recovery. During the World War the German Economic System underwent a drastic change owing to the pressure of the blockade, and the transition from Empire to Republic only increased the difficulties. But Germany has again astonished the world by her adjustment to the altered circumstances. Crop production and livestock have already reached the pre-War figures. The Germans themselves are not satisfied with these achievements. The Treaty of Versailles which is more than obnoxious to the German mind, made Germany look forward to a leader who would wipe out the disgrace of defeat, but the democratic parties lacked leaders. The policy of compromising with the former enemies to procure better international understanding and enduring peace was repugnant to the popular mind. This discontent was intensified by the general depression and the burden of taxes, and so the Nazi régimé under Hitler is a logical development of the countries which have suffered most from the defeat of the Central Powers. Austria is most unhappy. The old Austro-Hungarian Empire was a much better structure economically than either the present Austria or Hungary. The combination of the moderately industrial Austria with the essentially agrarian Hungary was a decided asset—united they prospered, divided they declined. Besides these disadvantages Austria is faced with the Anschlus problem, and has the unenviable task of preserving her integrity from the German or Italian advance.

The resurrection and the separation of Poland from the dismemberment of Russia is one of the many remarkable results of the World War. This is not merely because the recreation of a new state with a population of nearly 30 millions is an unusual achievement, but because it gave new proof that a strong sense of nationality could not easily be stifled and would revive whenever the time is opportune for its assertion. The problem of the Polish Corridor which gives Poland the right to use the Port of Danzig and access to the Baltic is one of the most vexed problems of Central Europe which is unfortunately complicated by ethnographical and economic consideration. Among all the countries of Europe there is none where the influence of geographic environment upon human occupation, temperament and political and social development is more conspicuous than in Russia. The splendid isolation of Russia has contributed not a little to the stability of the Soviet system. Communism is a novel experiment which would have come to nothing like the French Revolution but for the advantage it secured in the geographic location of the country. As yet, however, there is little indication that on their own initiative the Russians can mould a system which will so far overcome their physical handicap as to place them on a level with the countries around the North Sea. In fact the trend of history suggests that in the long run the North Sea countries may take the good and reject the bad of the Russian experiment, thus profiting more than Russia herself.

It is an accepted fact that Europe has greatly benefited by a singular combination of climate, location, mineral wealth and the distribution of land and water. The effect of these has been magnified by a post-glacial amelioration of climate rendering vast ice-bound areas fit for human habitation. On account of this the highly favoured north-western part of Europe has in recent times received groups of people who have by a selective process of migration eliminated the less efficient. Thus, Europe achieved

dominance though it is far from uniform. But one of the most important and least understood facts about Europe's non-uniformity is its great and systematic variation not only from north to south but also from east to west. Another important question is whether Europe with all its advantages will still hold its own in the face of rivalry from newer parts of the World? The future alone can determine, whether the diversity within the continent will increase as it seems to have done in the past or the late M. Briand's dream of an United States of Europe will come true.

The book is a notable contribution to the already extensive literature on Geography, and is distinguished at once by wide scholarship and vivid presentation. Of the numerous geographical books on Europe, this is entitled to be ranked as one of the best, which students and research scholars can study with profit.

C. N. R. R.

The Mysore Tribes and Castes. Vol. I. By Diwan Bahadur L. K. Anantha Krishna Iyer. (Published under the auspices of the Mysore University, 1935.) Pp. lxxii + 502. Price Rs. 15 or 24 *sh.*

The present volume is intended to be a general prefatory survey of the detailed descriptions of the customs and manners of the *Tribes and Castes of Mysore* which have been published in Vols. II–IV. These sumptuous volumes which are the fruits of indefatigable labour and patient field investigation form an indispensable work of reference to all research workers and students of Indology, providing at the same time a great mass of anthropological matter for the general reading public. Diwan Bahadur L. K. Anantha Krishna Iyer is the most senior Indian anthropologist whose publications have earned for him international reputation, and his works are characterised by sobriety of judgment and dispassionate and scholarly exposition. We congratulate the author and the University of Mysore on the successful completion of a great work.

The book is accompanied by two illuminating introductions by Dr. R. R. Marrat, Rector, Exeter College, Oxford, and the late Professor Sylvian Levi, the eminent Indologist of the Paris University. The prefatory note by the author explains the circumstances under which the work of writing these volumes was entrusted to him by the Government of His Highness the Maharaja of Mysore. Mr. F. J. Richards, who was for a long time Collector of the Civil and Military Station of Bangalore and one of the founders of the Mythic Society, has added a chapter on the *Cultural Geography of Mysore*. There are in all sixteen chapters, to which an appendix on Criminal Tribes is added. Several admirable photographic reproductions illustrate the volume.

"The present work may, in my opinion, be regarded as a model of such sociological research as an Indian student can undertake for the lasting benefit and renown of India." This verdict of Dr. Marrat will be generally endorsed by anthropologists into whose hands this volume might fall. The book confines itself strictly to the level of description of the characteristic habits and manners of the several tribes or social units comprising the entire population of the Mysore State, and the great merit of the book is that equal justice is made to each section of the community so as to provide a clear and comprehensive view of its social stratigraphy. Reading the four volumes together, perhaps the reader may not escape the feeling that there is repetition of a catalogue of disconnected facts, but it must be remembered that the Castes form separate pieces of a hierarchical puzzle, and the treatment of each piece independently, adopted by the author, is in the existing state of public affairs a wise one. The prime object of the author is not to overlook anything, however superficial and unimportant it might at first sight appear, but to subject them to a critical analysis by detailed description of the customs of each social group. This parallel study affords at the same time a cross-section view of the general common practices. Under the stress of foreign influence the old Indian customs are fast disappearing, and the author has done a great service by placing on record a true and faithful picture of the social faiths and practices of his countrymen, which would otherwise be lost to posterity.

The books must have an enduring value, and their author is worthy of great honour. There may be a few details in which we may not agree with the interpretation or view-point of the author, but judged on the whole, the four volumes constitute a significant and memorable contribution to anthropological science.

Mammals of Ceylon. By W. W. A. Phillips, F.Z.S., M.B.O.U. (Duncan & Co., Ltd., London, 1935.) Pp. xxvii + 373. Plates I-XXXVIII. Figs. 55. One map. Price Rs. 10 or 15*s*.

The latest addition to the Mammalian fauna of the Indian region is in the form of a comprehensive account of the *Mammals of Ceylon* by W. W. A. Phillips. The author whose acquaintance with the fauna of the island is due to his stay there for a number of years has brought out what is probably the first collected account of the distribution, characters and habits of the mammals of the island. Much of his knowledge is first-hand and there is very little previous literature to rely upon. In his chapter on the distribution of mammals on the island, the author discusses the geological evidence for the connection of Ceylon with the mainland, and basing his views mainly on those of Wayland, concludes that the recent geological history of Ceylon includes two subsidences and upheavals resulting in a double migration of man and animals from India. But for this the fauna of Ceylon would have been far more interesting than what it is to-day. The Primates are represented by three genera, *Macaca*, *Pithecus* and *Loris*. The last named is evidently the most interesting. It occurs in India also and the author basing his opinions on the work of Osman Hill, recognises three distinct races of the single species, *Loris tardigradus*, *Loris t. tardigradus*, *Loris t. nordicus*. The differences between these races seem to rest mostly on colour and size. Nobody who has any experience of these animals in the field and in captivity would fail to be struck with the great variations in colour and size of these forms. The terminology of the species is very confusing and the reviewer who has had opportunities of examining Dr. Hill's specimens in the Colombo Museum thinks there is really no justification for creating these different races. The climatic conditions in the different regions of the island are so varied that they must profoundly affect, temporarily at any rate, the colour and size of these forms. In India, a single species, *Loris lydekkerianus*, is recognised, which is probably synonymous with *L. tardigradus* of Ceylon.

The insectivore fauna of the island, represented by ten species belonging to four genera are interesting in that eight of these species are peculiar to the island. All the forms belong to the Crocidurinæ, the Soriscinæ being unrepresented in the island. Nearly ninety pages of the volume are devoted to a consideration of the Chiroptera of which there are a large number of species, many of them also represented in India. The carnivore fauna of the island is necessarily poor and Ceylon therefore is not the sportsman's paradise that India is. Of the Felidæ the only animal that offers any interest to the Shikari is the Indian Leopard, *Panthera pardus*, which is widely distributed in the dense jungles of the island. The habits of this form are not different from those of its Indian congener, except that, on account of the relative scarcity of its natural food in the Ceylon jungles, the animal has resorted to feeding on practically every denizen of the forest, with the possible exception of the elephant and the buffalo. Bears are common but the only species represented is the sloth bear, *Melursus ursinus*. A large number of species of rats and mice, animals which are probably the most intimately connected with man, are found on the island. An elephant, peculiar to Ceylon and slightly larger than the Indian form has been called *Elephas maximus zeylanicus*. Of the other mammals the Indian Pangolin, *Manis crassicaudata* is the most important. It is the only edentate in Ceylon and fairly common, though very infrequently encountered, on account of its living in burrows made in inaccessible regions. It lives on ants mainly but in captivity does not mind a varied diet.

The book, which is mainly useful to the layman, is therefore full of information to the collecting naturalist. A variety of information such as measurements of typical adults, distribution, sexual differences, colour, food, breeding behaviour and general habits is given and a complete index of the common English, Tamil, Singhalese and scientific names of the animals is appended. The illustrations which are excellent, include a number of photographs, many of which were taken in their natural environment.

B. R. S.

Electrolytic Oxidation and Reduction. By S. Glasstone, D.Sc., Ph.D., F.I.C., and A. Hickling, M.Sc., Ph.D. (Chapman & Hall, Ltd., London. 1935.) Pp. 420. Price 25/-.

The ninth volume of Dr. Howard Tripp's Monographs on Applied Chemistry maintains the standard of the earlier parts of the series. After a brief introduction on electrolysis one gets to business with a chapter on reversible electrode potentials. A moderately advanced knowledge of physics and chemistry is rightly assumed, since the whole series is intended for the trained chemist who desires to specialise. Beginning with the measurement of electrode potential and the various available methods and standards, polarisation and overvoltage are next considered; the theories of overvoltage are briefly but adequately described. Diffusion phenomena, whose significance in electrolytic reactions is insufficiently realised, are discussed in detail. The wide theoretical basis thus provided is followed up by individual oxidation and reduction processes, the reversible reactions of inorganic chemistry, irreversible organic reductions, irreversible inorganic reductions, the polymerisation of anions, the oxidation of fatty acids and their salts, irreversible organic and inorganic oxidations and anodic substitution being taken in order. The whole book is characterised by the soundness of the theoretical treatment and the wealth of detail. Each chapter is followed by an extensive bibliography. As an authoritative exposition of a branch of applied chemistry which is growing daily in technical importance and as a work of reference the book is invaluable; the technologist, however, would be inclined to regard the compilation of a somewhat perplexing array of electrochemical oxidations and reductions and the citation of literature as uncritical. Thus one obtains a very full account of the electrolytic reduction of nitrobenzene, but no indication is given of its practical futility so far as the manufacture of aniline is concerned. While, therefore, the authors' claim that few data of any importance have been omitted is wholly justified, the technical chemist who turns to the book for practical guidance in the exploration of the commercial possibilities of a given electrolytic method is apt to find some difficulty in seeing the wood for the trees.

K. V.

Forthcoming Events.

Central College Mathematical Society, Bangalore.—Mr. K. Venkatachala Iyengar will deliver a course of eight weekly lectures on "The Recent Advances in the Theory of Integral and Meromorphic Functions with Special Reference to Picard-Borel Theorem and Asymptotic Values."

Erratum.

Current Science, Vol. IV, No. 7, January 1936 on p. 484,
read S. N. Chakravarti *for* S. K. Chakravarti.

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